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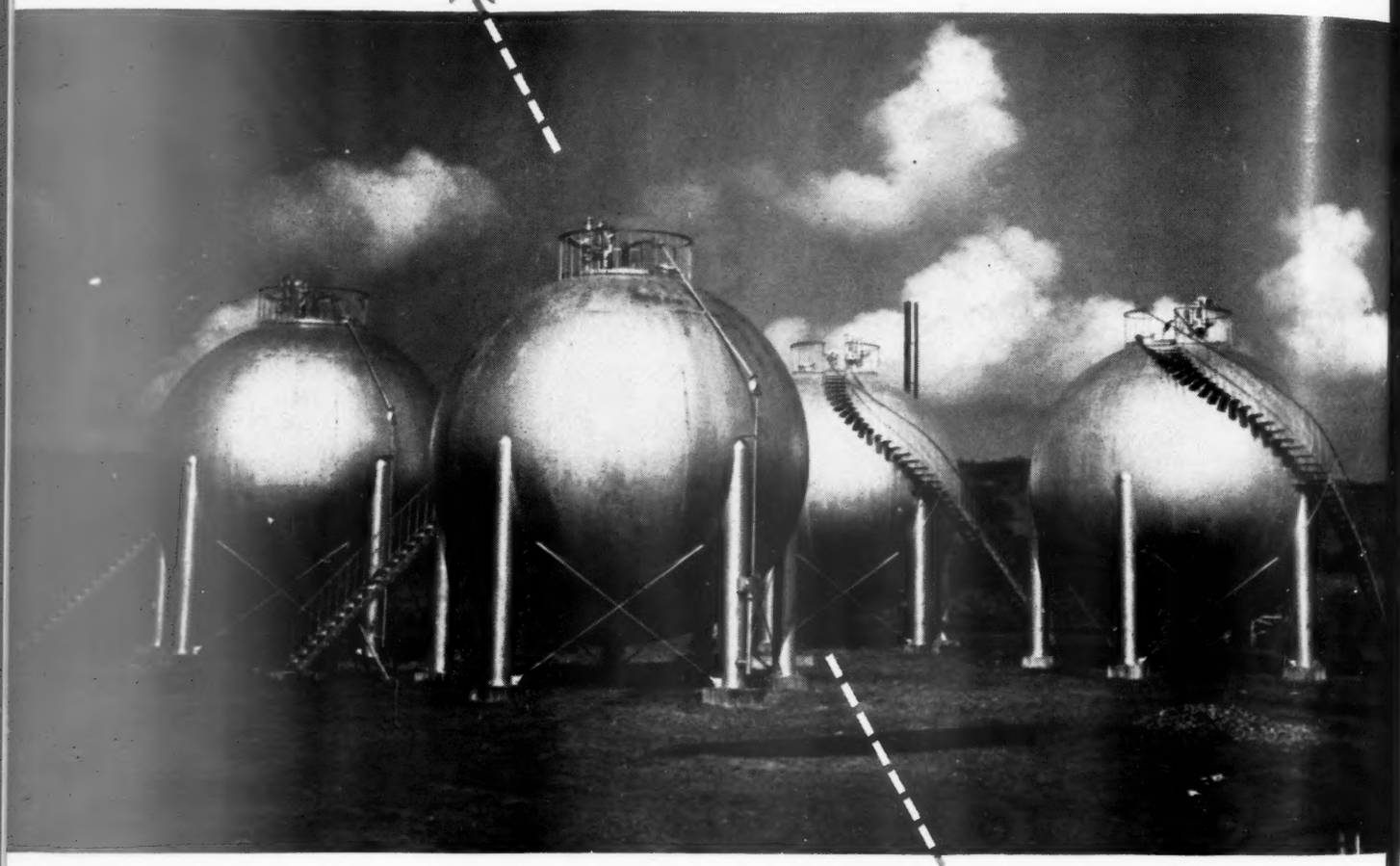
NOVEMBER 1951

HORTONSPHERES serve PEME



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OIL'S ANNUAL FORUM

THE 31ST ANNUAL MEETING of the American Petroleum Institute is being held this month in Chicago. No gathering during the year has the widespread appeal to the interests of oil men that this meeting holds. It is an event that has come to occupy this prominent place in the oil calendar mainly because of the vital character of the discussions and the deliberations that result therefrom. These affect the general welfare of the petroleum industry in all its ramifications. Here leaders in every branch of the business foregather to grapple with their common problems.

The Institute meeting this year affords the industry an opportunity to take stock of what has thus far been accomplished in the present national emergency and should aid it in overcoming difficulties during the months to come. With the industry in the throes of adapting itself to the changes that compliance with the national emergency regulations involves, there are certain aspects of the proceedings that arouse universal interest.

There will be prominent speakers to discuss the many factors that enter into present-day operations. What they have to say is expected to disclose an intimate picture of the problems and obstacles besetting the efforts of the oil industry in putting the regulations into effect. Conflicting angles of the regulations over which storms of controversial opinion have been raised may, it is hoped, be clarified sufficiently to dispel much of the confusion that now exists and pave the way to future progress.

Many papers are presented bearing on important operating phases of the production, refining, and transportation branches of the industry. The subject matter discussed in these papers represents the results and findings of many months of incessant labor in the field, the office, the laboratory, and the workshop. It is on such contributions as these that the progress of the oil industry is based. The discussions that follow the reading of the papers are a valuable and informative feature of the sessions. This interchange of opinion is a stimulus to thought and action leading to further improvements in practices and techniques.

Behind the scenes is the work of the standardization committees, whose membership is made up of men from the operating departments of oil companies and the equipment manufacturers. Their work involves a continuous program of observation, investigation, and study concerning the service life and operation of equipment in the field. Standardization has been one of the most important functions of the American Petroleum Institute, and has been successful in saving the industry vast sums in material and equipment costs.

The American Petroleum Institute embraces all branches of the oil industry and is a forum of action during which the industry takes stock of itself, its operations, its progress, its problems, and the future. In this respect it is a valuable medium for the interchange of opinion among the individual members, and in that connection fulfills a valuable function that aids in promoting the general welfare of the oil industry.—K.C.S.

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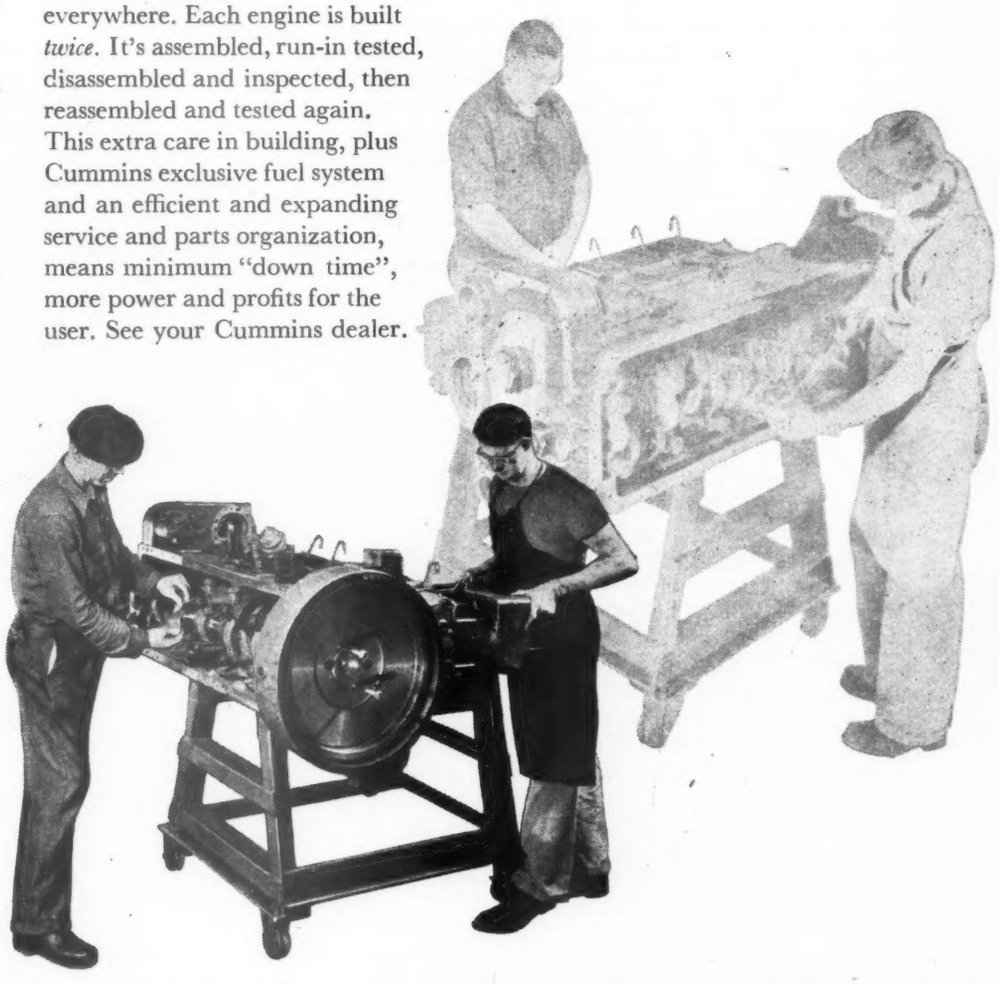

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With The EDITORS . . . . . .

Synthetic Rubber Production

To all those who witnessed the miracle of the development of a rubber synthesis which "synthesizes rubber," that accomplishment remains the greatest practical job done by America during the last half-century. And nothing is greater in that story than the continued importance of synthetic rubber in our "peacetime" economy. A fact that was totally unbelievable a decade ago, our present synthetic rubber production is greater than our total consumption of natural and synthetic rubber before the last war. Typical consumption in the late 1930's was between 600,000 and 700,000 long tons.

A few weeks ago OPS (Office of Price Stabilization, to you!) allowed a boost in raw synthetic rubber price from 24.5 cents to 26 cents per pound. This price increase, says RFC Administrator Symington, is necessary to permit boosting our current output rate from 760,000 tons to 860,000 tons per year. Further, the price increase is made necessary by the added cost of making synthetic rubber ingredient, butadiene, by the alcohol process. While this process is reported to be as successful, technically speaking, as the one making butadiene from butanes from refinery and natural gases, it is much more expensive to carry out. Koppers Company is expanding its facilities for making styrene, in Texas and at its near-Pittsburgh, Pennsylvania, plant, and uses alcohol as raw material for butadiene. The simple reason why more butadiene is not made from petroleum hydrocarbons is that all government petroleum-to-butadiene plants are already reactivated and working at capacity, and to produce more of the intermediate from this source will require construction of additional capacity. Evidently it is considered more practicable to reactivate the alcohol-based capacity than to build more petroleum-based butadiene plants, under present conditions. Even at that price it is pointed out that synthetic rubber, sold to industry at cost, is only half the price of natural rubber!—A.L.F.

Pipe Line Boom for Canada

During the last several years the pipe line industry has enjoyed a remarkable boom in the United States, a boom that is still in progress to the extent that steel allocations will permit. Now, a similar boom may be in the offing for Canada. Numerous applications for permits have been made to the Board of Transport Commissioners and, although some of them are overlapping, the construction of even a part will mean the adding of many thousands of miles of pipe lines to the Dominion's present limited system.

Decisions on all these proposals may not be reached until the spring of 1952, although the possibility exists that some of the companies may receive their "answer" before the end of this year.

One of the proposed lines, Trans-Canada Pipe Line, Ltd., would construct a 2240-mile system from Princess, Altamont, to Montreal, with laterals from Toronto west to Kitchener and Stratford and north from Morrisburg, Ontario, to Ottawa.

Trans-Northern Pipe Line has drawn up plans for a 444-mile line from Montreal to Toronto, Hamilton and Kitchener, and a lateral from Prescott to Ottawa.

The system of Western Pipe Lines would extend 1600 miles from the Pincher Creek field via Winnipeg to Duluth and Superior in the United States.

Two Alberta-to-Vancouver lines are proposed, one by Trans-Mountain Oil Pipe Line Company, the other by the Independent Pipe Line Corporation.

Pacific Northwest Pipe Line Corporation's system would be from Pincher Creek to supply British Columbia markets.

Another line from the Pincher Creek field is that proposed by Northwest Natural Gas Company. This one would go into Idaho and Washington in the United States.

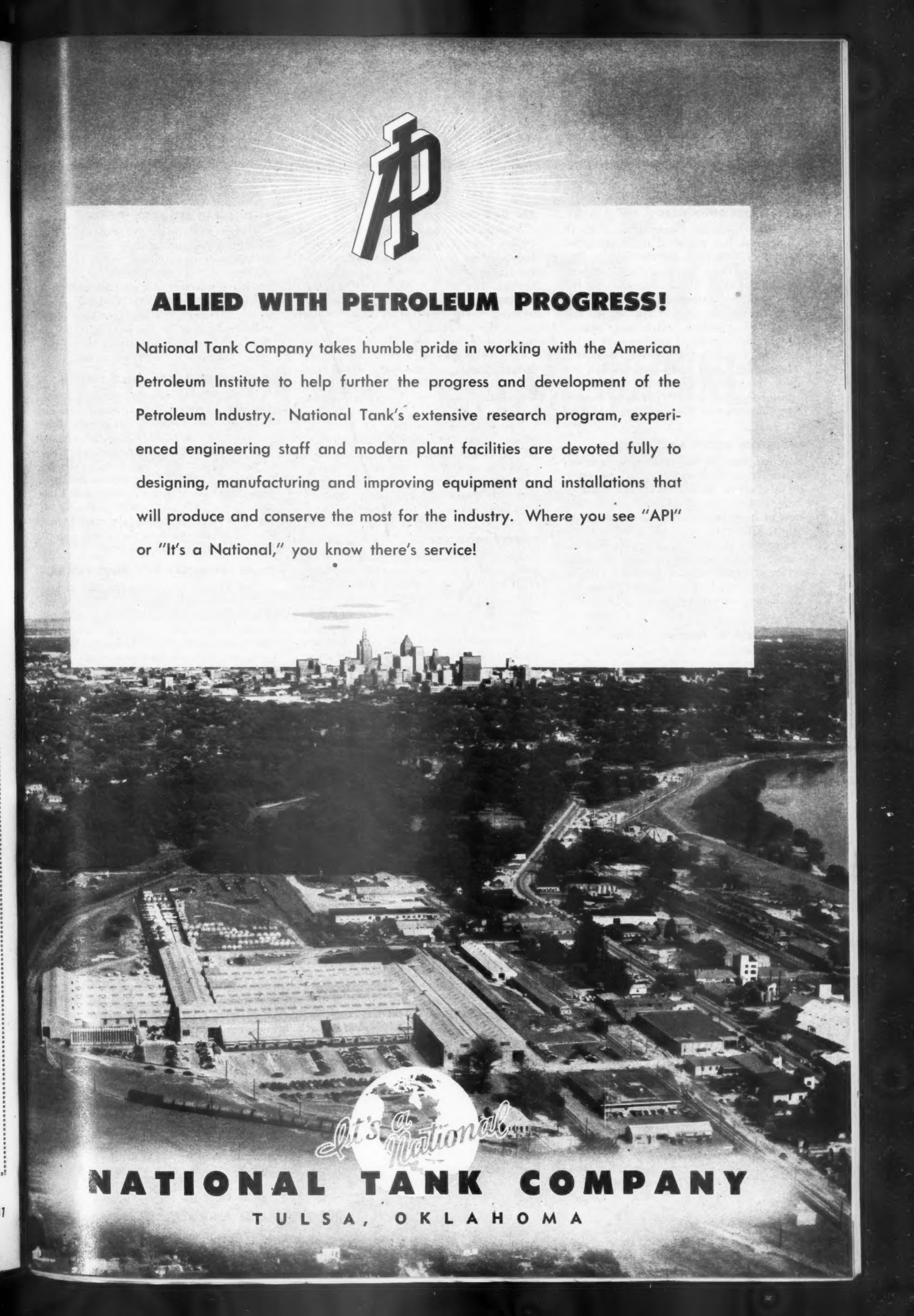
Westcoast Transmission suggests a line from the Pouce Coupé field in the extreme northwest part of Alberta to a point near Vancouver, where the system would branch, one line going into Vancouver, another to Washington and Oregon.

A system to be operated jointly by Canadian-Montana Pipe Line and Montana Power Company would export gas from Alberta to Montana.

These, briefly, are among the major pipe line systems that may be constructed during the next few years in the Dominion of Canada. They, together with the already operating Interprovincial Pipe Line, would serve to "unlock" oil and gas production, which has attained large proportions in Canada since the Leduc discovery, by making these products available to consuming areas. The effect on the Canadian economic structure will be far reaching.—F. H. L.

Tantalum in New Catalyst

Contract for the manufacture of a new catalyst for making butadiene from ethyl alcohol and acetaldehyde has been let to Davidson Chemical Corporation by Rubber Reserve. This catalyst is made up principally of 2 per cent of Tantalum Pentoxide on 98 per cent of silica gel, prepared in a suitable manner to make a satisfactory catalyst. According to announced statements, acetaldehyde, CH_3CHO, is condensed to crotonaldehyde, $CH_3CH{:}CHCHO$, by the silica gel; this is reduced to butadiene, $H_2C{:}CHCH{:}CH_2$, by the removal of hydrogen and oxygen by the tantala, the ethanol giving up hydrogen to facilitate the process. The yield of butadiene is reported to be about 60-64 per cent of the theoretical, ethers, alcohols ketones, etc., being formed as byproducts. Koppers Company and Carbide and Carbon Chemicals Company will use the catalyst. Although some 60 per cent of the total production of butadiene in 1944 was from alcohol, it is estimated that only about 20 per cent of our present and future butadiene will be from this source, the other 80 per cent coming from butane and butylenes from petroleum and natural gas.—A.L.F.



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HIGHLIGHTS IN OILDOM

GAS WASTE DENOUNCED

Texas Railroad Commissioner E. O. Thompson has reported to Dean Acheson, Secretary of State, that stepped-up oil production is causing "terrific damage" in Texas. He elaborated on the complaint by stating that increased output to offset the loss of Iranian oil has overtaxed gasoline extraction plants, causing hundreds of millions of cubic feet of casinghead gas to be flared. Thompson urged that the Abadan refinery be opened as soon as possible. A similar note was sent Acheson by Louisiana Conservation Commissioner Digby.

INVENTORS ACCEPT SINCLAIR OFFER

More than 10,000 responses have resulted from the Sinclair Plan, an offer of laboratory facilities and other aid to independent inventors with ideas for new or improved petroleum products or applications. Sinclair will receive right to use new product royalty free but inventor may make any outside business arrangement he wishes. Special facilities are being readied at Harvey, Illinois, laboratory to process first idea.

OPS REGULATES TUBULAR GOODS

The Office of Price Stabilization has issued a notice to all buyers and sellers of oil field tubular goods that they are responsible for the price they ask and give for these materials. Ceiling prices for both domestic and imported steel tubular goods are regulated by the OPS.

FREEDOM THREATENED IN U. S.: JONES

A call to American citizens to act promptly and vigorously if the U. S. is to escape the fate of the government-dominated countries of the Old World, was sounded in Beaumont, Texas, recently by W. Alton Jones, president of Cities Service Company.

Listing totalitarian policies leading to the downfall of other countries, Jones named some in the U. S., which he declared were parallel: Excessive borrowings, a huge national debt, deficits piled upon deficits, unbalanced budgets, confiscatory taxation, extravagant public works, and subsidies to various groups of citizens.

Also speaking in Beaumont was L. S. Wescoat, president of Pure Oil. Wescoat declared that a production cutback and rationing would result from rigid price controls on an industry that has had only a 19 per cent rise in the wholesale price of its products since 1926, compared with an 82 per cent hike in the wholesale price index of all commodities. Rigid price control "must inevitably lead to the curtailment of production, with the prospect of consumer rationing at the end of the trail," Wescoat warned.

FPC GAS RULES UP AGAIN

The question of whether the Federal Power Commission has jurisdiction over independent producers and gatherers of natural gas is due another round although the FPC refused Milwaukee, Wisconsin, and other petitioners a rehearing in the Phillips Petroleum Company, the question is on its way to the Supreme Court. Should the Supreme Court rule that FPC does have this authority, the independents would have to have another bill similar to the Kerr Gas Bill, vetoed by President Truman recently.

Speaking to a meeting of the Independent Natural Gas Association, Pratt Rather, PAD's deputy administrator for gas, reported that "too cheap" prices for natural gas made everyone want it, and that gas could not supply the entire fuel market of this country.

DEEPEST PRODUCER

The title of deepest oil producer ever completed was won recently by Shell Oil Company at its No. 1 Gonsoulin in Iberia Parish, Louisiana, in the Weeks Island pool. The well tested 188 bbl of oil, with gas-oil ratio of 15,370-to-1, in sand zone at 16,572-600 ft for deepest production test, but the hole was plugged back and well completed from zone at 15,269-336 ft for 466 bbl of oil a day. This is above the deep production in Standard of California's well on the West Coast.

RAINS RAISE ALUMINUM OUTPUT

Aluminum Company of America has reported that heavy rains in the Pacific Northwest have reduced production losses there by 73 per cent. Water levels at hydro-electric sites have been restored to the point where ALCOA estimates its drought-caused aluminum production losses will be about 2,200,000 lb this year instead of the 8,000,000 lb originally anticipated.

In its mid-October report to defense agencies, ALCOA revised its total 1951 production estimate to 853,400,000 lb.

ADEQUATE OIL SUPPLY SEEN

The U. S. Bureau of Mines estimates that the nation will have an adequate supply of oil this winter. Officials of the Petroleum Administration for Defense and other representatives of the oil industry agree. The B of M report states that some imports of crude oil and oil products have been cut due to shortages abroad, while exports have risen sharply.

The Bureau points out that high exports will continue to the end of 1951, but adds that refineries will have to run close to capacity to meet the requirements in the first three months of 1952.

STEEL SCRAP DECLARED URGENT

Defense Production Administrator Manly. Fleischmann has reported the shortage of steel scrap "is no longer a shortage, it is an emergency!" In an emergency conference on Iron and Steel Scrap Salvage held in Washington recently, Fleischmann declared that scrap collections may be the key to mobilization and possibly will spell the difference "between victory and defeat."

PIPE LINE EXPANSION HELD STYMIED

Harrington Wimberly, member of the Federal Power Control, warned members of the Texas Independent Producers and Royalty Owners Association in Tyler, Texas, recently that expansion of natural gas pipe lines may soon be brought to a halt. The reason he gave was that gas reserves have not kept pace with the long range planning of the pipe line builders. He urged producers to increase exploration with a view of stepping up reserves.

TEXAS PRODUCERS PAY HUGE TAX BILL

The Texas state treasury was richer by $126,000,000 at the end of the fiscal year 1951. This is the amount paid in by Texas oil and gas operators. Compared with other tax paying groups, indications are that the producers' tax share will be the highest percentage on record. The Texas Mid-Continent Oil and Gas Association reported that final comparative figures are not available yet, but preliminary calculations indicate, that the Texas producers paid a major share of the state's tax income for fiscal year ended August 31.

IPAA WANTS HIGHER CRUDE OIL PRICES

Members of the Independent Petroleum Association of America have drawn up a resolution demanding that Office of Price Stabilization raise the current crude price level. Meeting for the 22nd annual 2-day meeting, independent operators included in the resolution, in part, "a price that is at disparity with the general economy and the needs of the oil industry will impoverish our nation as to oil and, thereby render us defenseless."

IPAA officials stated that the $2.56 price per barrel of crude oil today is less than in 1948, while the prices on many items related to the production of oil have increased.

Another resolution was drawn up which declared the oil industry had not been allotted enough steel to meet its responsibilities under the defense program.

A demand of 8,025,000 bbl daily for the last quarter of this year and first quarter of 1952 was made by the economics committee. It said that this was a 6.6 per cent increase over the comparable period of 1950-51.

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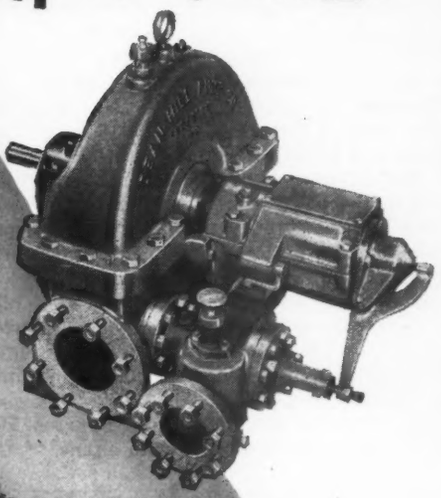

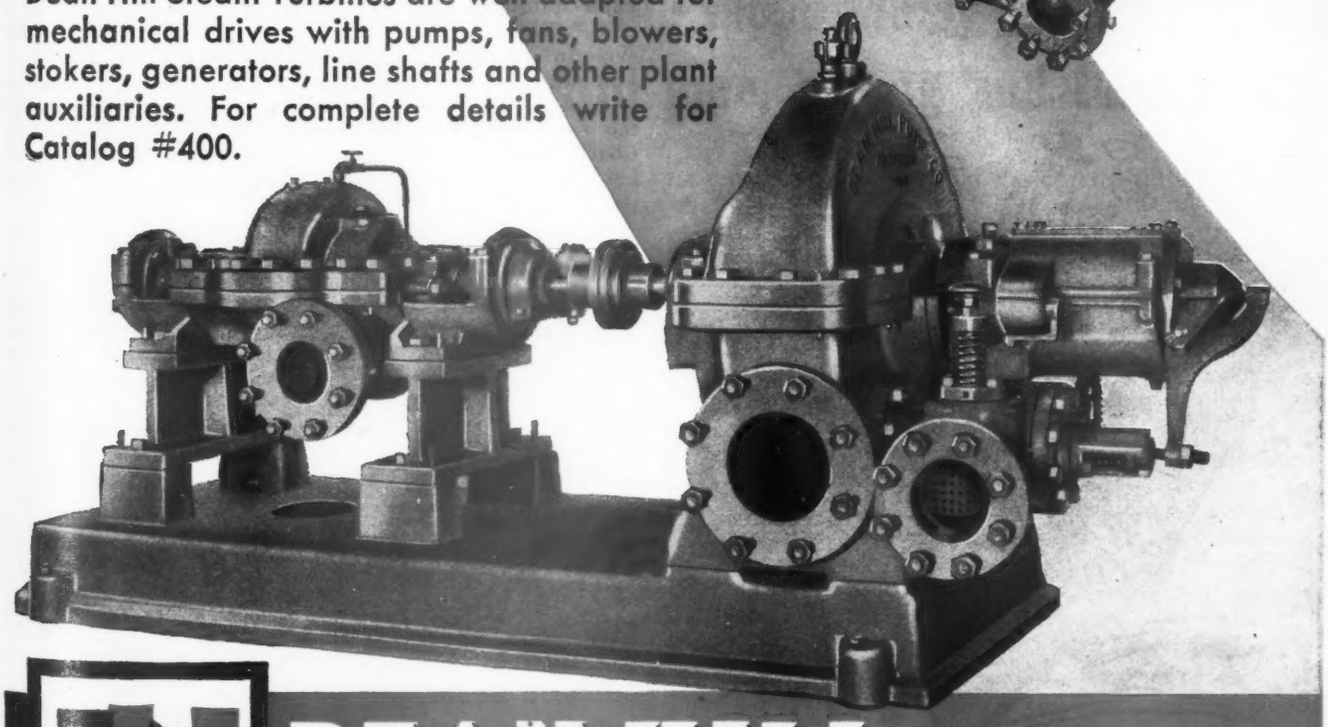

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PETROLIC PERSONALITIES

DICK SNEDDON

Delegation Infiltration

One of the most exciting infiltrations ever to hit the far west took place in Bakersfield, California, on Friday, October 12, when a substantial delegation of New York business executives zoomed out of the eastern sky into the San Joaquin Valley metropolis, were paraded through town in a sort of tumbril like French aristocrats going to the guillotine, and then by way of compensation for the rough ride were dined and wined by that ultra exclusive coterie, the Nineteeners. The visiting contingent traveled west in a big private Johns-Manville plane, piloted by Bill Vanderkloot, a former personal pilot to Winston Churchill, and included Joe Taylor, general purchasing agent of Socony Vacuum Oil Company, and Bill Beck, assistant manager of purchases for the same. Joe and Bill are both members of the Nineteeners so this was in reality a sort of home coming for them; Phil Hauck, general purchasing agent, and Frank Shlemmer, purchasing agent, from the Texas Company, another pair of Nineteeners; Henry McAdam, vice president of Jones and Laughlin Supply Company; Elmer Ogden, manager of the Columbian Rope Company; and Leslie A. Baldwin and Jack O'Brien, vice presidents of the Johns-Manville Company. John McLeod, president of the Macco Corporation also arrived in his own plane a few minutes after the New Yorkers and just in time to join them for the hayride.

The group was met at the airport by officers and members of the Nineteeners and was given a thorough serenading by Jascha Heifitz Tuttle and his discontented Stradivarius. A tiny majorette next led them aboard the tumbril to the rythmn of her whirling baton. Then they were escorted through the main streets of the town to the Bakersfield Inn by a brace of motor cycle cops complete with sirens.

They Gathered from Far and Near

Other interesting people who gathered in from distant parts and sojourned briefly but pleasantly with the Californians were Charles Schneider, president of Del Pazo y Cia, Sociedad Anonyma, Mexico City; Joe Hacker, vice president of the Ladish Company from Cudahy, Wisconsin; Alvin Zwerneman, president of Atlas Pipe Company, Incorporated, Houston, Texas; Marshall Peters, assistant manager of purchases, Humble Oil and Refining Company, Houston, Texas; Ed Fisher, sales manager, Pacific Wire Rope Company, Houston, Texas. Local guests included E. E. "Woody" Wood, former General Petroleum Corporation stores manager; Clayton Rose, assistant California sales manager, Axelson Manufacturing Company; and H. L. Pehrson, western manager for the Ladish Company; Ernie Taylor, western representative of American Flange and Manufacturing Company, and Joe's brother.

After the preliminary reception, the members took their guests out to the Stockdale Country Club where at the opening banquet, under the chairmanship of J. V. "Jim" MacDonald, western manager of Chain Belt Company, they were given a somewhat more formal welcome. On the following day those who were too tired to play golf or to transact any business locally gathered under the Schneider Oak at the ninth green and wisecracked the divot heavers into muffed approaches and multiple putts. The Schneider Oak, incidentally, is so called because Charlie Schneider comes up for the calcutta every year from Mexico City and come the first streak of dawn on the opening day is to be found under that tree dishing out reviving waters with a generous hand. The calcutta is a 36-hole affair spread over two days and a great deal of landscape. It takes virility to handle a job like that and Paul Huggins, the Western Gulf top executive, expressed the fear that before long all of the members might be found under the Schneider Oak watching one lone threesome carve its tortuous way through the sandtraps. That threesome would probably consist of Charlie Schriber, the Jorgensen vice president with the crew haircut; Bob Fluor, the Fluor Company executive who plays par golf, and Roy Fly, the Western Gulf purchasing agent.

Singing, Speaking, and Tax Collecting

Ken Norris, Norris Stamping and Manufacturing Company, enriched the coffers of the organization in a very large way by imposing levies for all sorts of misdemeanors and created a lot of fun in the process. Joe Taylor, one of our favorite narrators did some interesting reminiscing that was much enjoyed, and recounted the very recent distress of his sister-in-law when she looked out the window at the Bakersfield Inn and saw him going to his execution in the tumbril. Monte Lindmoe, the Southwest Welding Company, matinee idol, led the group in community singing and where he led them was surprising indeed. Thomas Watson Bell, the virtual organizer and stabilizer of Jones and Lauglin Company with the strong Caledonian accent, was as usual the author of one of the best cracks of the day. Ken Norris asked him if he would like to say a few words, so Tom rose to his feet and said "Certainly!" Then clearing his throat in the traditional manner he moved meeting adjourn.

Calcutta Bestowed on Brown

Many of the members held open house in the afternoons and early evenings and some of them made more mileage between suites than they did through the sandtraps on the golf course. Incidentally, the winner of the calcutta was Roger Brown, Bethlehem Supply Company's San Joaquin Valley representative, who happened to be playing on his home course and was well rewarded for taking the shortest route. The New Yorkers remained in Bakersfield over most of the weekend, looking over the Valley oil fields and other matters of interest.

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And the wells are going deeper. Total footage for the first quarter is estimated as 7% over last year.

These figures are important to drilling contractors, because it means that equipment is going to take a record amount of abuse. So, it's good to know that your men and equipment are backed with National Seamless Drill Pipe, Casing, and Tubing. Despite the greater depth of wells being drilled and the greater punishment tubular material must endure, National Seamless is a sure-fire guarantee of top service.

No greater security has been incorporated with any tubular product than that provided by the seamless process of manufacture. You can work it hard and deep. Its traditional rugged strength in resisting fatigue and twisting action, and its unsurpassed collapse resistance, are your best defense against deep hole trouble.

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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

WALLS WITHOUT WELDS

USS

NATIONAL SEAMLESS DRILL PIPE, CASING AND TUBING

UNITED STATES STEEL

LETTERS *to the* EDITORS

Leave It to the Girls

To The Petroleum Engineer:

Your article in The Petroleum Engineer August issue, "Oil Women Form Own Organization" interests me mightily.

I would like very much to form a group in Parkersburg. We do have several girls who lunch one day each week together to "gab" and naturally our work comes into the conversation.

All of our drilling in West Virginia is with cable tools, so you can imagine the interest with which I had tall tales to tell the girls upon my return from the West Coast this past June.

Ruby Stoetzer
Joe Rubin
Parkersburg, West Virginia

Renews Subscription

To The Petroleum Engineer:

I have had much pleasure, information and help from The Petroleum Engineer, and thank you for this opportunity to continue my subscription at the outgoing rate.

W. D. Layton,
Managing Director
Premium Petroleums Ltd.
3220 West 4th Ave.
Vancouver, B. C., Canada

Misunderstanding Corrected

To The Petroleum Engineer:

It has been brought to our attention that there are various interpretations and understandings covering the effects of the sale of our Supply Stores Division.

The sale of the Ideco Supply Stores Division to the Jarecki International Supply Division of the H. K. Porter Company consisted only of inventory and physical properties of the supply stores. The notes and accounts receivable were not involved in this transaction.

The domestic sale of Ideco products through authorized Ideco distributors, the Ideco Export Division, and the manufacturing operations continue as heretofore under the sole ownership of the Ideco Division, Dresser Equipment Company.

Geo. W. Walton,
Vice President
Dresser Equipment Company
Ideco Division,
Dallas, Texas

Following the Furrows

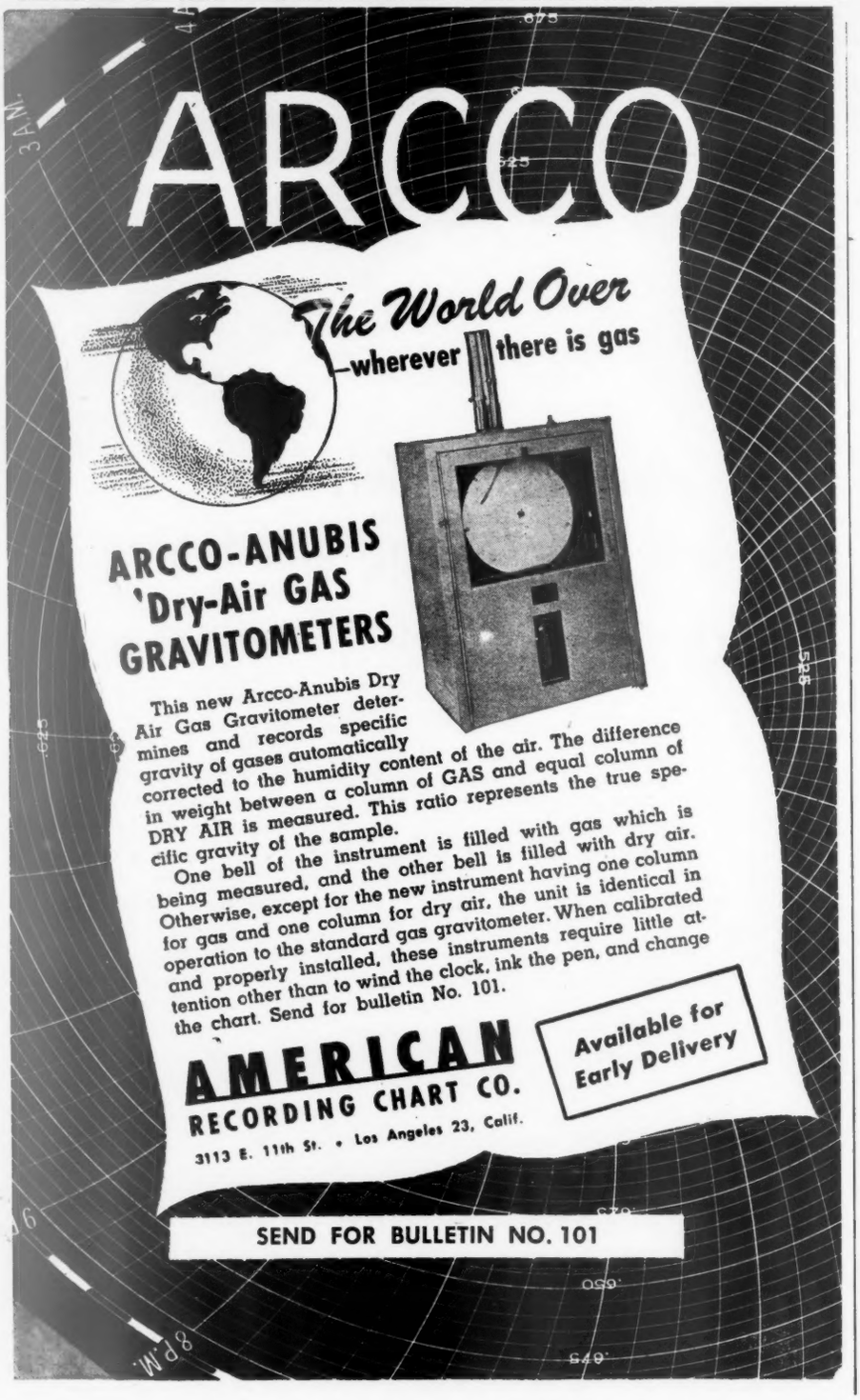
By spraying a field of beans with a light petroleum oil at night instead of during the day, an oil company has wiped out weeds without damage to the bean plants on its experimental farms. These experiments may lead to a brand new kind of weed control.

Shrewd scientific detective work on the habits of crop leaves forms the basis of the experiments. Because the leaves of beans and many other crops close their breathing pores when the evening sun goes down, a nocturnal oil bath does not affect them. On the other hand, the grasses remain wide open to attack by oil after dark.

This spraying technique uses a volatile oil that evaporates before sunup, when the beans and many other crops resume normal growth, unhampered by the grass whose tissues have been destroyed overnight.

The new spray still is experimental. Two difficulties must be resolved before practical application. In the first place, the oil is inflammable and might be a hazard in some farming operations. A second question is how many farmers would want to stay up nights to keep grasses down?

This is only one of the experiments that make up the competitive research on which oil companies expend $100,000,000 annually.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AMERICAN PETROLEUM INSTITUTE

thirty-first annual meeting

AMONG the distinguished persons who will address the American Petroleum Institute's 31st annual meeting in Chicago, Illinois, this month are: Secretary of the Interior Oscar L. Chapman, Petroleum Administrator for Defense, General Omar N. Bradley, chairman of the joint chiefs of staff, and Governor Allan Shivers of Texas. Frank M. Porter, president of API, and the 1951 recipient of the API "Gold Medal for Distinguished Achievement" will also address the meeting, which is being held November 5 to 8.

The Stevens Hotel and the Palmer House are being used for the four-day meet. The Stevens is general headquarters, and in addition, will house all general, group, and committee sessions, except those of the Division of Transportation. Headquarters for the transportation section are in the Palmer House, and all transportation sessions will be held there.

This year's meeting of the API has added a new session on fundamental research, which features remarks and papers by such outstanding scientists as Dr. Robert E. Wilson, board chairman for Standard Oil Company (Indiana); C. E. ZoBell, Scripps Institution of Oceanography; F. P. Shepard, also of Scripps; B. H. Sage, California Institute of Technology; W. L. Whitehead, of Massachusetts Institute of Technology, and many others.

There will also be a session on protection of petroleum facilities, which will feature papers by Ned H. Dearborn, president of the National Safety Council; Vice Admiral Merlin O'Neill, Commandant of the U. S. Coast Guard, and Rear Admiral B. B. Biggs (USN), of the Munitions Board.

API board of directors meets both morning and afternoon on November 6, and in the afternoon, November 7. The board of councilors meets Tuesday morning, November 6 to nominate candidates for election to the board of directors. At the first general session, Wednesday morning, November 7 the report of the board of councilors and the election of the directors will take place. A new board chairman is to be elected to succeed W. Alton Jones, who is completing the second of two one-year terms permitted by the Institutes by-laws.

Sessions on fundamental research, agriculture, marketing, and protection of petroleum facilities will be held Monday, November 5. Scheduled for the second day, Tuesday, are: Interdivisional symposium on the outlook of steel for the oil industry; group sessions for the divisions of marketing, transportation, and production, and for the financial and accounting committee; an American Petroleum Industries Committee, and the lubrication committee.

A general session in the morning, and group sessions in the afternoon for the division of production, refining, and transportation will be held Wednesday, November 7. One of the outstanding papers for the division of production session will be J. Terry Duce's report on "The Outlook in the Near East".

ROBERT E. WILSON
Standard Oil Company (Indiana)
Chicago, Illinois
API Director and Chairman of the Research Committee

L. E. ELKINS
Stanolind Oil and Gas Company
Tulsa, Oklahoma
Chairman of the Advisory Committee

A. R. DENISON
Amerada Petroleum Corporation
Tulsa, Oklahoma
Chairman, API Research Project 51 Advisory Committee

ROBERT EARL LOECK
California Research Corporation
Chairman, API Research Project 47 Advisory Committee

J. R. MULVEY
Humble Oil and Refining Company
Houston, Texas
Chairman, API Financial and Accounting Committee

ANDREW G. ANDERSON
Socony-Vacuum Oil Company, Inc.
New York, New York
Chairman, API Committee on Law and Regulation

JOHN L. DUPREE
Ivy Lee and T. J. Ross
New York, New York
Chairman of the Oil Industry Information Committee

E. A. SNYDER
Socony-Vacuum Oil Company, Inc.
New York, New York
API Committee on Agriculture

Set for the last day of the meeting is a general session in the morning, and a luncheon meeting of the API executive committee at noon.

Sessions for the Oil Industry Information Committee began on Saturday, November 3, and are continuing through Wednesday, to be concluded with a luncheon on Thursday. During this meeting the committee's program for 1952 will be completed and presented to the API board for approval, and new officers will be elected. The 1951 Chairman is John L. Dupree, who represents Socony-Vacuum Oil Company.

Other meetings held in conjunction with the API annual meet are the yearly dinners of the Transportation, Pipe-Liners, and the Twenty-five Year Clubs. The Association of Petroleum Writers also is holding its annual meeting and election of officers at this time.

Monday, November 5, 1951

Group Sessions

(At Stevens Hotel)

Fundamental Research

9:00 AM—*Open Forum — Research on Occurrence and Recovery of Petroleum:* North Ball Room. Sponsored by the Advisory Committee on Fundamental Research on Occurrence and Recovery of Petroleum. Presiding: Lloyd E. Elkins, Chairman, Advisory Committee; Stanolind Oil and Gas Company, Tulsa, Okla.

Opening Remarks: Robert E. Wilson, Chairman, Research Committee of the Board of Directors.

Some Observations on the Role of Bacteria and Radioactivity on the Origin of Oil (Project 43). D. H. Clewell, Chairman, Project Advisory Committee; Magnolia Petroleum Company, Dallas, Texas: C. E. ZoBell, Director, Project 43A, Scripps Institution of Oceanography, University of California, La Jolla, California; and W. L. Whitehead, Director, Project 43C, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Objectives of Sedimentology Research on the Gulf of Mexico (Project 51). A. R. Denison, Chairman, Project Advisory Committee; Amerada Petroleum Corp., Tulsa; F. P. Shepard, Director, Project 51, Scripps Institution of Oceanography, University of California, La Jolla, California.

Understanding the Behavior of Fluids in Petroleum Reservoirs (Project 37). C. V. Millikan, Chairman, Project Advisory Committee; Amerada Petroleum Corporation, Tulsa; B. H. Sage, Co-director, Project 37, California Institute of Technology, Pasadena.

Fluid Movement Through Petroleum Reservoirs (Project 47). R. E. Loeck, Chairman, Project Advisory Committee; California Research Corporation, San Francisco; J. A. Putnam, Director, Project 47A, University of California, Berkeley; and Alfred Chatenever, Acting Director, Project 47B, University of Oklahoma, Norman.

Agricultural Session

10:00 AM—North Assembly Rm. Presiding: E. A. Snyder, Socony-Vacuum, New York.

Address: Don Lerch, of Bailey and Lerch, and *Washington Farm Reporter*, Washington, D. C.

Address: Prof. Randall C. Swanson, College of Agriculture, University of Wisconsin, Madison.

Preview showing of "Farm Tractor Safety" —Sound-color film.

Protection of Petroleum Facilities

8:00 PM—*Facility Security:* North Ball Rm. Presiding: W. R. Boyd III, director, Facility Security Division, PAD.

Personnel Security. Ned H. Dearborn, president, National Safety Council, Chicago.

Port Security. Vice Admiral Merlin O'Neill, Commandant, U. S. Coast Guard.

Effect of Plant Security Upon Military Supply. Rear Admiral B. B. Biggs, Munitions Board, Washington.

Tuesday, November 6, 1951

Interdivisional Symposium

10:00 AM—*Outlook for Steel for the Oil Industry:* South Ball Rm. (Sponsored by API Interim Advisory Committee on Alloy Steels). Presiding: B. B. Wescott, Gulf Research and Development, Pittsburgh.

A symposium on the availability and procurement of steel for the oil industry.

American Petroleum Industries Committee

2:00 PM—*Open Forum*—"It's *Your* Business!" North Ball Rm. Presiding: Oscar John Dorwin, The Texas Co., New York.

Address: Speaker to be announced.

Presentation of API Certificate of Appreciation.

Response by Recipient.

Color-Film Presentation—It's *Your* Business!"

Financial and Accounting

9:30 AM—Upper Tower. Presiding: J. R. Mulvey, Humble, Houston, Texas.

Papers on the following subjects will be presented: *The Growth in Demand for Petroleum Products and Its Financial Implications; Financing the New Capital Requirements of Petroleum-Industry Expansion; The Economic and Financial Outlook for the Expansion Period.*

2:00 PM—Upper Tower. Presiding: J. R. Mulvey.

Papers on the following subjects will be presented: *Financial and Accounting Implications of Federal Income and Excess-Profits Taxes; Allocation and Control of Distribution Costs of Refined Products; Cost Controls in the Refining Operation.*

W. ALTON JONES
Cities Service Company
New York, New York
Chairman, API Board of Directors

FRANK M. PORTER
Fain-Porter Drilling Company
Oklahoma City, Oklahoma
President's Address at a General Session

General Sessions

Wednesday, November 7, 1951

9:30 AM—Grand Ball Rm. Presiding: W. Alton Jones, Cities Service Company.

Report of Board of Councillors and Election of Directors.

President's Remarks: Frank M. Porter, President, American Petroleum Institute.

Presentation of Gold Medal for Distinguished Achievement.

Response by Recipient.

Address: Hon. Oscar L. Chapman, Secretary of the Interior; Petroleum Administrator for Defense, Washington, D. C.

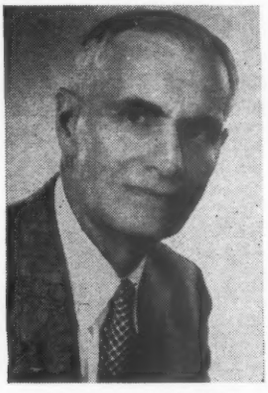
Thursday, November 8, 1951

9:30 AM—Grand Ball Rm. Presiding: W. Alton Jones, Cities Service Company, New York.

Address: Hon. Allan Shivers, Governor of Texas, Austin, Texas.

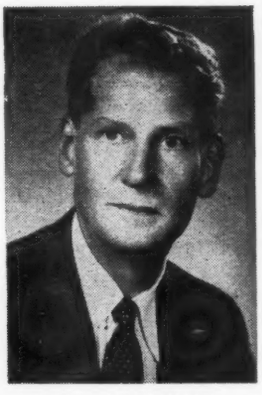
Address: General of the Army Omar N. Bradley, Chairman of the Joint Chiefs of Staff, Washington, D. C.

JOHN A. RITTER
Sun Oil Company
Dallas, Texas
Chairman, API Production
Vocational Training



FREDERIC H. LAHEE
Sun Oil Company
Dallas, Texas
Chairman, API Committee
on Reserves

H. H. KAVELER
Phillips Petroleum Company
Bartlesville, Oklahoma
Speaker,
Division of Production



W. L. WHITEHEAD
Massachusetts Institute
of Technology, Cambridge
Speaker, Open Forum
On Research

FRANK H. WILLIBRAND
Sohio Petroleum Company
Oklahoma City, Oklahoma
Chairman, API Production
Nominating Committee

JOHN R. SUMAN
Standard Oil Company
(New Jersey)
New York, New York
Chairman, Standardization,
Oil-Field Equipment

FRANCIS P. SHEPARD
Scripps Institution
of Oceanography
University of California
La Jolla, California
Speaker, Open Forum
on Research

C. V. MILLIKAN
Amerada Petroleum
Corporation
Tulsa, Oklahoma
Chairman, API Research
Project 37
Advisory Committee

BLAINE B. WESCOTT
Gulf Research
and Development
Chairman, Subcommittee
on Pipe Research and
Interim Advisory Committee
on Alloy Steels

SIDNEY A. SWENSRUD
Gulf Oil Corporation
Pittsburgh, Pennsylvania
Pittsburgh
Chairman, API Agricultural
Advisory Committee

Division of Production

Group Sessions

(Stevens Hotel—Grand Ball Room)

Tuesday, November 6, 1951

1:30 PM—Presiding: W. L. McCloy, Jr., Sohio Petroleum Company, Oklahoma City, and Glenn M. Stearns, British-American Oil Producing Company, Tulsa, Oklahoma.

Development of an API Thread Compound. M. G. Mayberry, Mellon Institute of Industrial Research, Pittsburgh, Pennsylvania.

Note: This is the result of two years of research at the Mellon Institute in Pittsburgh, sponsored by the API Committee on Standardization of Oil-Country Tubular Goods and financed by voluntary contributions from oil and gas companies and pipe manufacturers.

Progress in Unitization. H. H. Kaveler, Phillips Petroleum Company, Bartlesville, Oklahoma.

Current Aspects of Some Important Water-Injection Projects. Paul D. Torrey, Consultant, Austin, Texas.

2:00 PM—Presiding: R. O. Garrett, Arkansas Fuel Oil Company, Shreveport, Louisiana; and George E. Cannon, Humble Oil and Refining Company, Houston, Texas.

Presentation of API Certificates of Appreciation.

The Outlook in the Near East. J. Terry Duce, Arabian-American Oil Company, New York.

Importance of Technological Growth as a Contribution to U. S. Productive Capacity. C. E. Reistle, Jr., Humble Oil and Refining Company, Houston, Texas.

DIVISION OF PRODUCTION
Committee Meetings

Saturday, November 3, 1951

9:00 AM—*Production Section of the API Interim Advisory Committee on Alloy Steels.* Private Dining Rm 4. Ch: B. B Wescott.

Sunday, November 4, 1951

9:00 AM—*Production Section of the API Interim Advisory Committee on Alloy Steels.* Rm. 14. Ch: B. B. Wescott.

10:00 AM—*Subcommittee on Supervisory Development.* Rm 519A. Ch: F. H. Willibrand.

2:00 PM—*Special Project Committee on Permeability (Code 27).* Private Dining Rm 6. Ch: George H. Fancher.

6:00 PM—*Publications Committee (of the Central Committee on Drilling and Production Practice) (Dinner).* Private Dining Rm 3. Ch: H. H. Kaveler.

Monday, November 5, 1951

9:00 AM—*Central Committee on Measuring, Sampling, and Testing Natural Gas and Natural Gasoline.* Rm 12. Ch: George P. Bunn.

9:00 AM—*Steering Committee on Drilling Practice.* Rm 13. Ch: W. L. McCloy, Jr.

9:00 AM—*Special Subcommittee on Pipe Research.* South Ball Rm. Ch: B. B. Wescott.

9:00 AM—*Special Subcommittee on Drill Collars.* Rm 14. Ch: C. W. Alcorn.

9:00 AM—*Engineers Subcommittee on Oil-Well Cements.* Rm 19. Ch: George C. Howard.

9:00 AM—*API - AWS Conference Committee on Tank Welding.* Rm 18. Ch: H. O. Hill.

2:00 PM—*Steering Committee on Production Practice.* Rm 13. Ch: Glenn M. Stearns.

2:00 PM—*Central Committee on Vocational Training.* Rm 12. Ch: John A. Ritter.

2:00 PM—*Subcommittee on Production Tanks.* Rm 14. Ch: J. H. Field.

2:00 PM—*Special Subcommittee on Pipe Research (Symposium on Care and Use of Oil-Field Casing).* South Ball Rm. Ch: B. B. Wescott.

Note: A paper entitled "Influence of Tension and Compression on Straightness and Buckling of Tubular Goods in Oil Wells," by Arthur Lubinski, Stanolind Oil and Gas Company, will be presented.

2:00 PM—*Manufacturers' Subcommittee on Storage Tanks.* Rm 18. Ch: H. C. Boardman.

6:00 PM—*Program Committee (of the Central Committee on Drilling and Production Practice) (Dinner).* Private Din. Rm 3. Ch: George E. Cannon.

Tuesday, November 6, 1951

9:00 AM—*Executive Committee on Drilling and Production Practice.* Rm 12. Ch: R. O. Garrett.

9:00 AM—*Joint Meeting on Storage Tanks (All Day).* Rm 14. Presiding: C. C. Ashley.

9:00 AM—*Manufacturers' Subcommittee on Oil-Well Cements.* Private Din Rm 5. Ch: N. C. Ludwig.

12:15 PM—*General Committee, Division of Production (Luncheon).* Normandie Lounge. Ch: J. C. Donnell II.

2:00 PM—*Central Committee on District Activities.* Rm 13. Ch: Lot Bowen.

2:00 PM—*Joint Meeting on Oil-Well Cements.* Private Din Rm 5. Presiding: C. W. Dawson.

4:00 PM—*Nominating Committee, Division of Production.* Private Din Rm 10. Ch: F. H. Willibrand.

Wednesday, November 7, 1951

9:00 AM—*Central Committee on Standardization of Oil-Field Equipment.* North Assembly Rm. Ch: John R. Suman.

W. L. McCLOY, JR.
Sohio Petroleum Company
Oklahoma City, Oklahoma
Chairman, Steering Committee
on Drilling Practice

ARTHUR LUBINSKI
Stanolind Oil and Gas
Tulsa, Oklahoma
Speaker, API Special
Subcommittee
on Pipe Research

R. O. GARRETT
Arkansas Fuel Oil Company
Shreveport, Louisiana
Chairman, API Executive
Committee on Drilling and
Production Practice

CHARLES W. ALCORN
Falcon Seaboard
Drilling Company
Houston, Texas
Chairman, Special Subcommittee on Drill Collars

M. G. MAYBERRY
Mellon Institute of
Industrial Research
Pittsburgh, Pennsylvania
Speaker, Division of
Production Session

GLENN M. STEARNS
British-American Oil
Producing Company
Tulsa, Oklahoma
Chairman, API Steering
Committee on
Production Practice

JAMES TERRY DUCE
Arabian-American Oil Company
New York, New York
Speaker, Division of
Production Session

JOSEPH H. FIELD
Sohio Petroleum Company
Oklahoma City, Oklahoma
Chairman, API Division of
Production's Subcommittee
on Production Tanks

C. E. REISTLE, JR.
Humble Oil and Refining
Company
Houston, Texas
Speaker, Division of
Production Session

GEORGE E. CANNON
Humble Oil and Refining
Houston, Texas
Co-presiding Officer, Division
of Production Session

GEORGE P. BUNN
Phillips Petroleum Company
Bartlesville, Oklahoma
Chairman,
Central Committee
on Measuring, Sampling,
and Testing Natural
Gas and Natural Gasoline

C. C. ("CHET") ASHLEY
Consulting Mechanical Engineer
Redwood City, California
Presiding Officer, Joint Meeting
on Storage Tanks

E. F. VOSS
Humble Oil and Refining Company
Houston, Texas
Chairman, Subcommittee on Mechanical Equipment

N. J. REES
Socony-Vacuum Oil Company, Inc.
New York, New York
Chairman, Subcommittee on Unfired Pressure Vessels

W. L. BOWLER
The Pure Oil Company
Chicago, Illinois
Chairman, Subcommittee on Field-Assembled Pressure Vessels

H. C. BOARDMAN
Chicago Bridge and Iron Company
Chairman, Subcommittees on Field-Assembled Pressure Vessels and on Storage Tanks

W. P. KLIMENT
The Crane Company
Chicago, Illinois
Chairman, Subcommittee on Refinery Valves

Division of Refining

Group Sessions

(All at Stevens Hotel)

Tuesday November 6, 1951

2:00 PM—*Lubrication Session:* South Ball Rm.

Wednesday, November 7, 1951

2:00 PM—*Refining Session:* North Ball Rm. Presiding: W. L. Stewart, Jr., Union Oil Company of California, Los Angeles.

Committee Meetings

(All at Stevens Hotel)

Friday, November 2, 1951

9:00 AM—*Subcommittee on Corrosion (All Day).* Private Din Rm 1. Ch: E. Q. Camp.

9:00 AM—*Manufacturers' Subcommittee on Safety and Relief Valves (All Day).* Private Din Rm 3. Ch: L. P. Stillman.

Saturday, November 3, 1951

9:00 AM—*Joint Meeting (All Day):* Private Din Rm 2.
Subcommittee on Field-Assembled Pressure Vessels (W. L. Bowler, Ch).
Manufacturers' Subcommittee on Field-Assembled Pressure Vessels (H. C. Boardman, Ch).

9:00 AM—*Manufacturers' Subcommittee on Refinery Valves.* Private Din Rm 3. Ch: W. P. Kliment.

2:00 PM—*Subcommittee on Valves.* Private Din Rm 3. Ch: R. H. Bungay.

Sunday, November 4, 1951

9:00 AM—*Committee on Petroleum Products.* North Assembly Rm. Ch: A. E. Miller.

9:00 AM—*Subcommittee on Pressure-relieving Systems.* Private Din Rm 8. Ch: J. C. Souder.

1:00 PM—*Automotive Research Committee.* North Assembly Rm. Ch: John T. McCoy.

1:00 PM—*Subcommittee on Unfired Pressure Vessels.* Private Din Rm 8. Ch: N. J. Rees.

Monday, November 5, 1951

9:00 AM—*Joint Meeting:* Private Din Rm 4.
Subcommittee on Mechanical Equipment (E. F. Voss, Ch).
Manufacturers' Subcommittee on Centrifugal Pumps (Lynn Sawyer, Ch).

9:00 AM—*Subcommittee on Electrical Equipment.* Private Din Rm 3. Ch: L. M. Goldsmith.

2:00 PM—*Committee on Refinery Equipment.* Private Din Rm 2. Ch: W. H. Creel.

2:00 PM—*Subcommittee on Instruments.* Private Din Rm 6. Ch: G. N. Ehly.

5:00 PM—*Nominating Committee, Division of Refining.* Private Din Rm 5. Ch: C. M. Ridgway.

Tuesday, November 6, 1951

9:00 AM—*Program Committee, Division of Refining.* Private Din Rm 8. Ch: W. M. Holaday.

11:00 AM—*Advisory Committee, Division of Refining.* Private Din Rm 8. Ch: C. E. Davis.

2:00 PM—*General Committee, Division of Refining.* West Ball Rm. Ch: W. L. Stewart, Jr.

CHARLES M. RIDGWAY
The Pure Oil Company
Crystal Lake, Illinois
Chairman, Nominating Committee of Division of Refining

A. E. MILLER
Sinclair Refining Company
New York, New York
Chairman, API Committee on Petroleum Products

W. M. HOLADAY
Socony-Vacuum Oil Company, Inc.
New York, New York
Chairman, Program Committee, Division of Refining

WILLIAM LYMAN STEWART, JR.
Union Oil Company of California
Los Angeles, California
API Vice President for Division of Refining

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H. H. ANDERSON
Shell Pipe Line Coporation
Houston, Texas
Presiding Officer
Joint Meeting
on Pipe Line Technology

J. H. PEPER
The Buckeye Pipe Line
Company, New York
Chairman, API Central Committee on Pipe Line
Transportation

T. E. SWIGART
Shell Pipe Line Corporation
Houston, Texas
Presiding Officer
Group Session

Division of Transportation

Group Sessions

Tuesday, November 6, 1951

(Palmer House—Red Lacquer Room)

10:45 AM—*Pipe-Line Symposium:* Presiding: J. H. Peper, The Buckeye Pipe Line Company, New York, N. Y.

The Structural Design of Flexible Protective Casings for Pipe Lines. M. G. Spangler, Iowa State College, Ames, Iowa.

Developments in Products Pipe-Line Technology. J. R. Shipley, The Standard Oil Company (Ohio), St. Louis, Mo.

Minimizing Pump-Station Fire Hazards. P. D. Phillips and F. O. Stivers, Humble Pipe Line Company, Houston, Texas.

Can Contractors Discuss Pipe-Line Construction Contracts? Richard A. Gump, Pipe-Line Contractors Chapter of Association of General Contractors, Dallas, Texas.

2:00 PM—*Pipe-Line Symposium:* Presiding: J. H. Peper.

Developments in Automatic Gaging, Sampling, and Testing Equipment. F. H. Warren, The Ohio Oil Company, Findlay.

Developments in Pipe-Line Communications. V. J. Sittel, Service Pipe Line Company, Tulsa, Okla.

Cold-Weather Pipelining. T. S. Johnston, Interprovincial Oil Pipe-Line Company, Toronto, Canada.

Sound-Technicolor Film—Artery for Oil.

Wednesday, November 7, 1951

2:00 PM—*Transportation Session:* Presiding: T. E. Swigart, Shell Pipe Line Corporation, Houston, Texas.

Address: Delos W. Rentzel, under-Secretary of Commerce for Transporation.

Presentation of API Certificates of Appreciation. By T. E. Swigart, vice president for Transportation.

Address: James K. Knudson, Administrator of the Defense Transport Administration.

Report of Division's Nominating Committee. A. G. Anderson, Socony-Vacuum Oil Company, Inc., New York, N. Y., Chairman.

Election of Members of the General Committee of the Division of Transportation.

Address: George A. Wilson, Director, Supply and Transportation Division, PAD.

Committee Meetings

Sunday, November 4, 1951

(All at Palmer House)

9:00 AM—*Subcommittee on Lease-Tank Practices.* Private Din Rm 11. Ch: R. Charles Nicholson.

10:00 AM—*Subcommittee for Joint ASME-API Volumeter Research.* Private Din Rm 9. Ch: L. S. Wrightsman.

Monday, November 5, 1951

9:00 AM—*Central Committee on Radio Facilities (All Day).* Private Din Rm 9. Ch: F. W. Littell.

9:00 AM—*Committee on Car Service.* Crystal Room. Ch: B. C. Graves.

9:00 AM—*Joint Meeting (All Day).* Red Lacquer Rm. Presiding: H. H. Anderson.
Committee on Pipe-Line Technology (H. H. Anderson, Ch).
Subcommittee on External Corrosion (L. F. Scherer, Ch).
Subcommittee on Products Pipe-Line Technology (J. W. de Groot, Ch).
Subcommittee on Internal Corrosion of Crude-Oil Pipe Lines and Tanks (R. A. Brannon, Ch).
Subcommittee on Lease Tank Practices (R. Charles Nicholson, Ch).
Subcommittee for Joint ASME-API Volumeter Research (L. S. Wrightsman, Ch).
Subcommittee on Pipe-Line Hydraulics (J. M. Evans, Ch).
Subcommittee on Pipe-Line Crossings (R. H. Lynch, Ch).
Subcommittee on Pipe-Line Construction Practices (J. C. Stirling, Ch).
Subcommittee on Vocational Training (J. R. Mills, Jr., Ch).

9:00 AM—*Committee on Railroad Equipment.* Private Din Rm 8. Ch: James E. Moss.

9:00 AM—*Joint Meeting (All Day).* Private Din Rm 7.
Committee on Regulations (Automotive) (M. E. Nuttila, Ch).
Committee on Engineering (Automotive) (J. J. Powelson, Ch).

2:00 PM—*Central Committee on Transportation by Water.* Private Din Rm 8. Ch: J. P. Patterson.

2:00 PM—*Central Committee on Railroad Transportation.* Crystal Rm. Ch: Fayette B. Dow.

4:30 PM—*Committee on Law and Regulation.* Private Din Rm 11. Ch: A. G. Anderson.

Tuesday, November 6, 1951

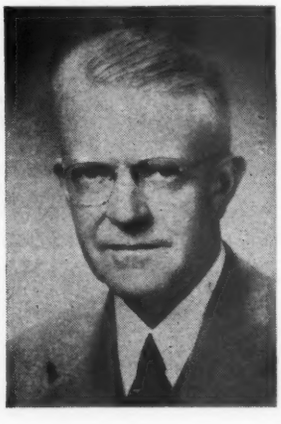
9:00 AM—*Central Committee on Automotive Transportation.* Private Din Rm 9. Ch: A. B. Gorman.

9:00 AM—*Central Committee on Pipe-Line Transportation.* Red Lacquer Rm. Ch: J. H. Peper.

12:30 PM—*General Committee, Division of Transportation. Luncheon.* Crystal Rm. Ch: T. E. Swigart.

4:30 PM—*Nominating Committee, Division of Transportation.* Private Din Rm 8. Ch: A. G. Anderson.

JOHN MARSHALL EVANS
Standard Oil Company of California
San Francisco, California
Chairman, Subcommittee on Pipe Line Hydraulics



JOHN W. de GROOT
Tuscarora Oil Company, Ltd.
Harrisburg, Pennsylvania
Chairman, Subcommittee on Pipe Line Technology

R. A. BRANNON
Humble Pipe Line Company
Houston, Texas
Chairman, Subcommittee on Internal Corrosion of Crude Oil Pipe Lines and Tanks

API Awards Valuable Members

Thirteen men will be awarded Certificates of Appreciation at API's thirty-first annual meeting. The citations will be presented by the Division of Production at a group session on Wednesday, November 7, in the Stevens Hotel.

Recipients of the awards are:

R. L. Wheelock, Wheelock and Collins, Corsicana, Texas, who has been a member of the Board of Directors since 1938 and vice president for production and chairman, general committee of the Division of Production, in 1949 and 1950; R. B. Kelly, The Pure Oil Company, Fort Worth; A. C. Rubel, Union Oil Company of California, Los Angeles; A. W. Thompson, Thompson-Carr, Inc., Houston; C. D. Watson, resigned, formerly with The Carter Oil Company; B. B. Wescott, Gulf Research and Development, Pittsburgh.

Seven producers will receive their certificates "for long and faithful service to the Institute's standardization program," as follows:

D. O. Barrett, retired, formerly with Gulf Oil Corporation, Tulsa; D. R. Dale, The S. M. Jones Company, Toledo; C. A. Dunlop, Humble Oil and Refining Company, Houston; T. C. Ervin, Lucey Boiler and Manufacturing Company, Chattanooga; Glenver McConnell, retired, formerly with Shell Oil Company, Tulsa; Turner C. Smith, General Petroleum Corporation, Los Angeles; C. R. Weiss, Link Belt, Indianapolis.

Non-Divisional Committees

Friday, November 2, 1951

10:00 am Underground Gasoline-Storage Tanks. (Stevens—Private Din. Rm. 9) Ch: J. Howard Myers.

10:00 am Advisory on Fundamental Research on Occurrence and Recovery of Petroleum (all day). (Stevens—West Ball Room) Ch: Lloyd E. Elkins.

2:00 pm Research Project 43 Chemical Subcommittee. (Stevens—Private Din. Rm. 4) Ch: L. M. Henderson.

2:00 pm Storage-Tank Venting. (Stevens—Private Din. Rm. 9) Ch: O. W. Johnson.

4:00 pm Tank Cleaning. (Stevens—Private Din. Rm. 9) Ch: E. K. Locher.

Saturday, November 3, 1951

9:00 am Awards (Accident). (Stevens—Private Din. Rm. 9) Ch: H. T. Markee.

10:00 am Oil Industry Information (Buffet Luncheon at Noon) (all day). (Stevens—West Ball Room) Ch: John L. Dupree.

10:00 am Research Project 51 Advisory (all day). (Stevens—Private Din. Rm. 1) Ch: A. R. Denison.

10:00 am Spark-Ignition Properties of Hand Tools. (Stevens—Private Din. Rm. 10) Ch: O. W. Johnson.

10:00 am Research Project 47 Advisory Committee (all day). (Stevens—Rm. 14) Ch: R. E. Loeck.

1:00 pm Cleaning Mobile Tanks. (Stevens—Private Din. Rm. 9) Ch: J. Howard Myers.

2:00 pm Code 25 Subgroup on Tests for BS&W. (Stevens—Private Din. Rm. 10) Ch: P. L. DeVerter.
Ch: P. L. DeVerter.

3:00 pm Planning and Central Committees on Accident Prevention. (Stevens—Private Din. Rm. 9) Ch: C. L. Hightower.

Sunday, November 4, 1951

9:00 am Oil Industry Information (Buffet luncheon at noon) (all day). (Stevens—West Ball Room) Ch: John L. Dupree.

9:00 am Code 25 Subgroup on Tank Measurement and Calibration. (Stevens—Private Din. Rm. 3) Ch: Bowman Brannon.

9:00 am Code 25 Subgroup on Automatic Devices. (Stevens—Private Din. Rm. 1) Ch: F. H. Warren.

9:30 am Statistical Advisory (all day). (Stevens—Private Din. Rm. 10) Ch: Henry Schwall.

10:00 am Safe Marketing Practices. (Stevens—Private Din. Rm. 9) Ch. F. R. McLean.

10:00 am Research Project 43 Advisory (all day). (Stevens—Private Din. Rm. 2) Ch: D. H. Clewell.

10:00 am Research Project 44 Advisory. (Stevens—Private Din. Rm. 4) Ch: W. E. Kuhn.

10:00 am Research Project 42 Advisory (all day). (Stevens—Rm. 13) Ch: Harry Sutherland.

2:00 pm Code 25—Measuring, Sampling, and Testing of Crude Oil. (Stevens—Private Din. Rm. 1) Ch: H. H. Anderson.

2:00 pm Visual Aids. (Stevens—Private Din. Rm. 9) Ch: C. R. Coneway.

4:00 pm Static and Stray Currents. (Stevens—Private Din. Rm. 4) Ch: J. M. Pearson.

4:00 pm Personal Protective Equipment. (Stevens—Private Din. Rm. 9) Ch: J. Howard Myers.

8:00 pm Liquefied Petroleum Gas. (Stevens—Private Din. Rm. 2) Ch: E. H. Barlow.

Monday, November 5, 1951

9:00 am Oil Industry Information (Buffet luncheon at noon) (all day). (Stevens—West Ball Room) Ch: John L. Dupree.

9:00 am Fire-Protection Regulations. (Stevens—Room 545) Ch: W. N. Young.

9:30 am Financial and Accounting (Stevens—Lower Tower) Ch: J. R. Mulvey.

9:30 am Aviation Advisory Committee. (Stevens—Private Din. Rm. 9) Ch: R. F. Bradley.

10:00 am Safety in Drilling and Production Operations. (Stevens—Rm. 546) Ch: John Hammermann, Jr.

12:30 pm Public Relations of Board of Directors (luncheon). (Stevens—Private Din. Rm. 1) Ch: John M. Lovejoy.

12:30 pm Joint Meeting (luncheon). (Stevens—Private Din. Rm. 10).
Aviation Advisory
Aviation Technical Services

2:00 pm Aviation Technical Services. (Stevens—Private Din. Rm. 9) Ch: W. D. Parker.

2:00 pm Financial and Accounting. (Stevens—Lower Tower) Ch: J. R. Mulvey.

2:00 pm Research Project 6 Advisory. (Stevens—Private Din. Rm. 4) Ch: S. S. Shaffer.

2:00 pm Fire-Protection Engineering. (Stevens—Rm. 545) Ch: J. E. Hill.

2:00 pm Research Project 37 Advisory. (Stevens—Private Din. Rm. 8) Ch: C. V. Millikan.

2:00 pm Research Project 48 Advisory. (Stevens—Room 523) Ch: W. D. Seyfried.

2:00 pm Protection of Petroleum Facilities. (Stevens—North Assembly Rm.) Ch: J. Howard Myers.

2:00 pm Accident Statistics. (Stevens—Rm. 521) Ch: J. Willard Lord.

2:00 pm Advisory on Agriculture. (Stevens—Private Dining Room 3) Ch: S. A. Swensrud.

7:00 pm Executive Committee of Advisory Committee on Fundamental Research on Composition and Properties of Petroleum (dinner). (Stevens—Private Din. Rm. 4) Ch: H. G. Vesper.

Tuesday, November 6, 1951

9:00 am Oil Industry Information (Buffet luncheon at noon) (all day). (Stevens—Lower Tower) Ch: John L. Dupree.

9:00 am Agriculture (all day). (Stevens—Rm. 18) Ch: E. A. Snyder.

9:00 am Central on Fire Protection. (Stevens—Rm. 521) Ch: R. T. Henderson.

9:00 am Highways. (Stevens—Private Din. Rm. 10) Ch: R. L. Milligan.

10:00 am Advisory on Fundamental Research on Occurrence and Recovery of Petroleum. (Stevens—West Ball Room) Ch: Lloyd E. Elkins.

10:00 am Research Project 45 Advisory. (Stevens—Rm. 13) Ch: W. G. Lovell.

12:15 pm Joint Meeting (luncheon). (Stevens—Rm. 522)
Central Committee on Accident Prevention (W. O. Wilson, Ch).
Central Committee on Fire Protection (R. T. Henderson, Ch).

2:00 pm Defense Services. (Stevens—Private Din. Rm. 8) Ch: E. W. Berlin.

2:00 pm Advisory on Fundamental Research on Composition and Properties of Petroleum. (Stevens—Private Din. Rm. 4) Ch: H. G. Vesper.

2:00 pm Planning Committee, Central Committee on Fire Protection. (Stevens—Private Din. Rm. 9) Ch: R. T. Henderson.

4:00 pm First Aid. (Stevens—Private Din. Rm. 9) Ch: C. A. Miller.

12:30 pm Research Committee of the Board of Directors (luncheon). (Stevens—Private Din. Rm. 4) Ch: Robert E. Wilson.

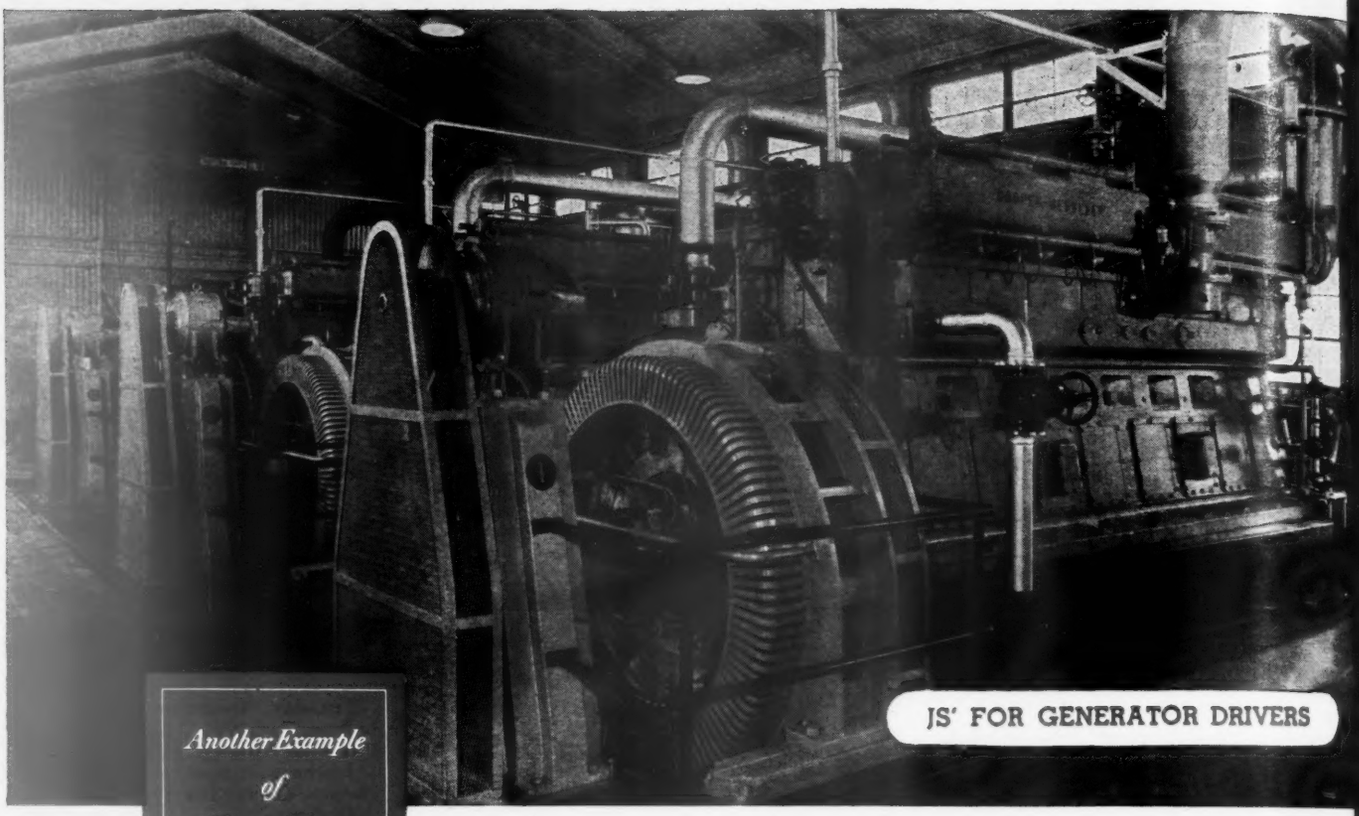
1:00 pm Central Committee on Accident Prevention. (Stevens—Rm. 14) Ch: W. O. Wilson.

2:00 pm American Petroleum Industries—Open Meeting. (Stevens—West Ball Room) Ch: Oscar John Dorwin.

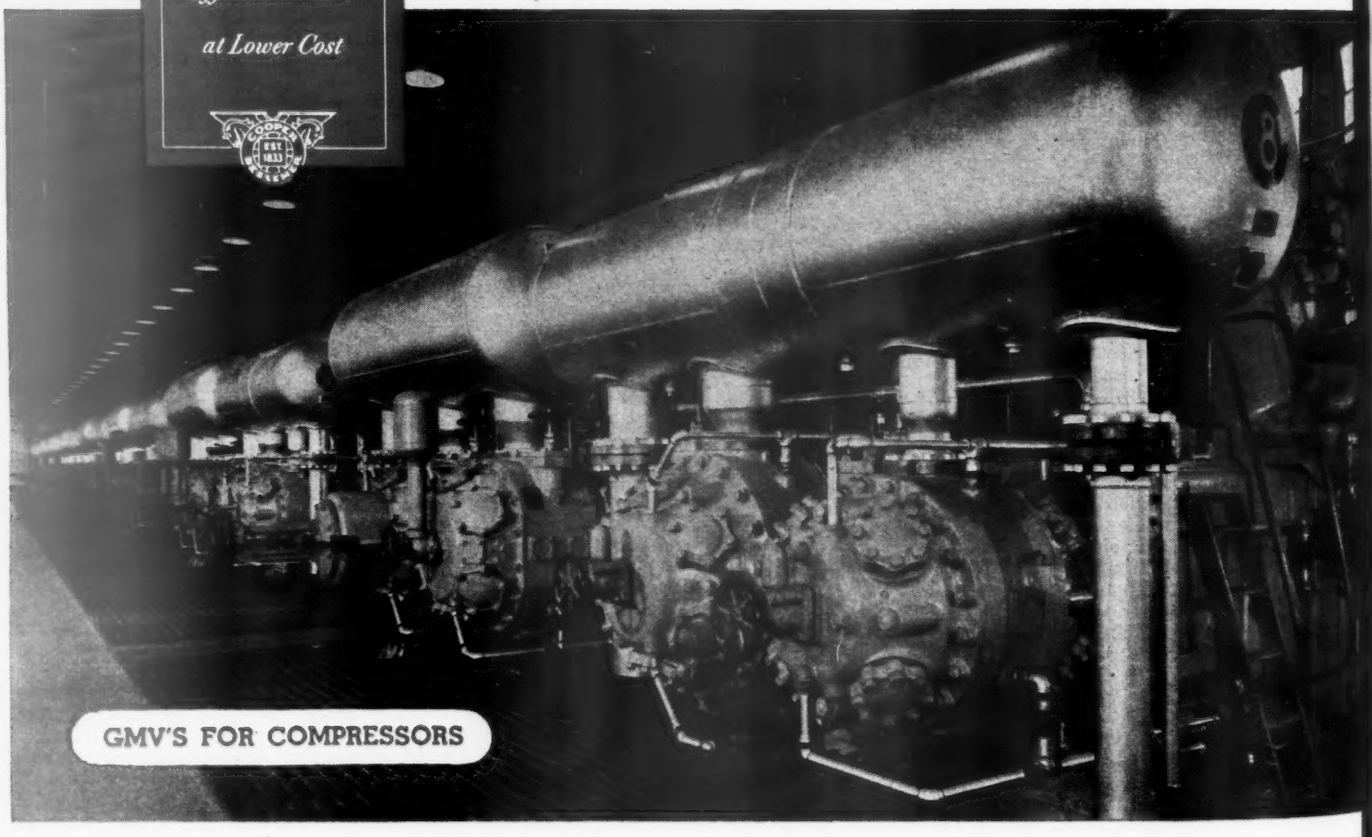
2:00 pm Oil Industry Information. (Stevens—North Assembly Room) Ch: John L. Dupree.

Thursday, November 8, 1951

12:30 pm Oil Industry Information (luncheon). (Stevens—North Assembly Room) Ch: John L. Dupree. * *



Another Example of Efficient Power at Lower Cost



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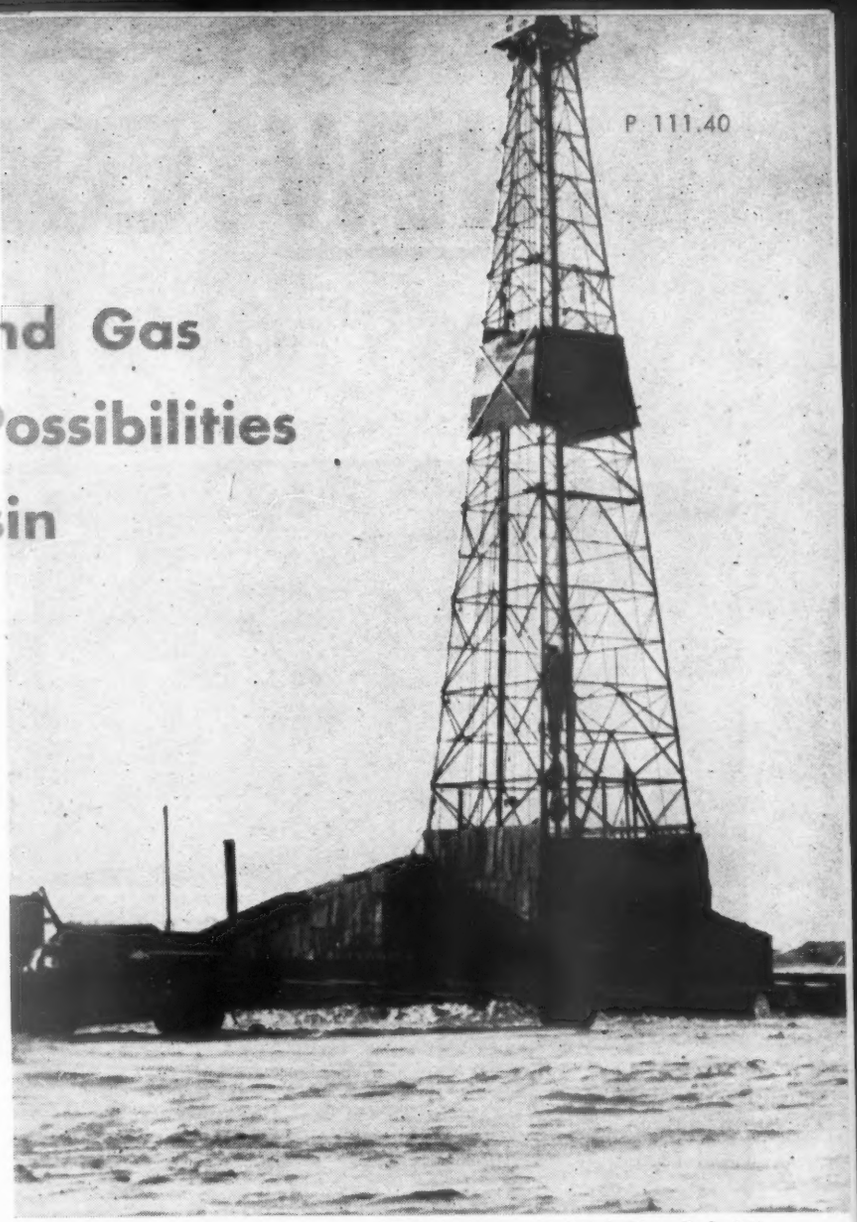
North Dakota

Geology and Oil and Gas Development and Possibilities of the Williston Basin

DONALD F. TOWSE



(Photo by Wilson M. Laird, State Geologist)

North Dakota's discovery well, Amerada No. 1 Clarence Iverson, in Williams County, North Dakota

NORTH DAKOTA'S first oil well, Amerada's Clarence Iverson No. 1, on the Nesson anticline in southern Williams County, tested oil in Devonian strata early this spring and went on production in July. That well, also the first for the large, little known Williston Basin, has caused a great increase in activity and interest in the geology of North Dakota. The development to date and the geology and stratigraphy of North Dakota and its relation to possible future development and oil possibilities are discussed in this article.

Four dry holes were completed in the state in 1950, one well was drilling, and one was suspended at the end of the year. During the first nine months of 1951 one oil well was completed, and seven tests had been unsuccessful. Six wells are drilling, and four other locations are reported ready to be drilled. One drilling well, the Amerada Bakken No. 1, on the Nesson anticline 10 miles north of the discovery well, will be a commercial producer in the Mississippian. A late count shows that 14 seismograph and five gravity parties are active in the state.

Developments in the Williston Basin in states and provinces contiguous to North Dakota are closely watched by North Dakota geologists. During the year two other widely separated areas in the basin have had commercial discoveries. The California Standard Daly 15-18 well west of Virden, Manitoba had the first commercial show of oil in Manitoba in January. It is capable of producing 8 to 10 bbl of 33 deg black oil per day from the Mississippian Madison limestone. The Daly 7-12 well in the Virden field pumped 20 to 25 bbl of oil per day initially. There are now four wells in the Virden field, and development is continuing. Discovery followed seismic and gravity work by California Standard, and it is especially interesting in that producing depths are only 2000 to 3000 ft.

On the west side of the basin, in Dawson County, Montana, Shell's N.P.R.R. No. 1 Richey area well flowed substantial quantities of 38 deg oil from the 7183 to 7353 ft zone, probably in the Charles formation. That well is located on a seismograph high apparently related to the northward extension of the Cedar Creek anticline and is a projected Ordovician test.

Four Devonian or Ordovician tests are currently drilling on the Cedar Creek anticline, and the Shell Oil Company is drilling a deep test in the southern part of the Williston Basin in Perkins County, South Dakota.

In Saskatchewan, the Shell Oil Company is drilling another deep test at Big Muddy Lake, just north of the Montana boundary. Farther west, in southwestern Saskatchewan, the Socony-Vacuum Exploration Company Tompkins No. 1 well, LSD 14, Sec. 19, T. 13, R. 20 W. 3rd P.M., tested a show of light oil and 2,071,000 cu ft of gas per day in the sandy limestone of the Jurassic Hulett formation at a depth of 3631 to 3661 ft. That well is of interest because rocks of similar lithology and age are widespread in North Dakota. Shell's Dahinda No. 1 well, Section 2, T. 9, R. 23 W., 2nd P.M., bailed 25 bbl of 20 deg oil per day from fractured Mississippian dolomite at 4694 to 4704 ft. It has been acidized and testing is continuing.

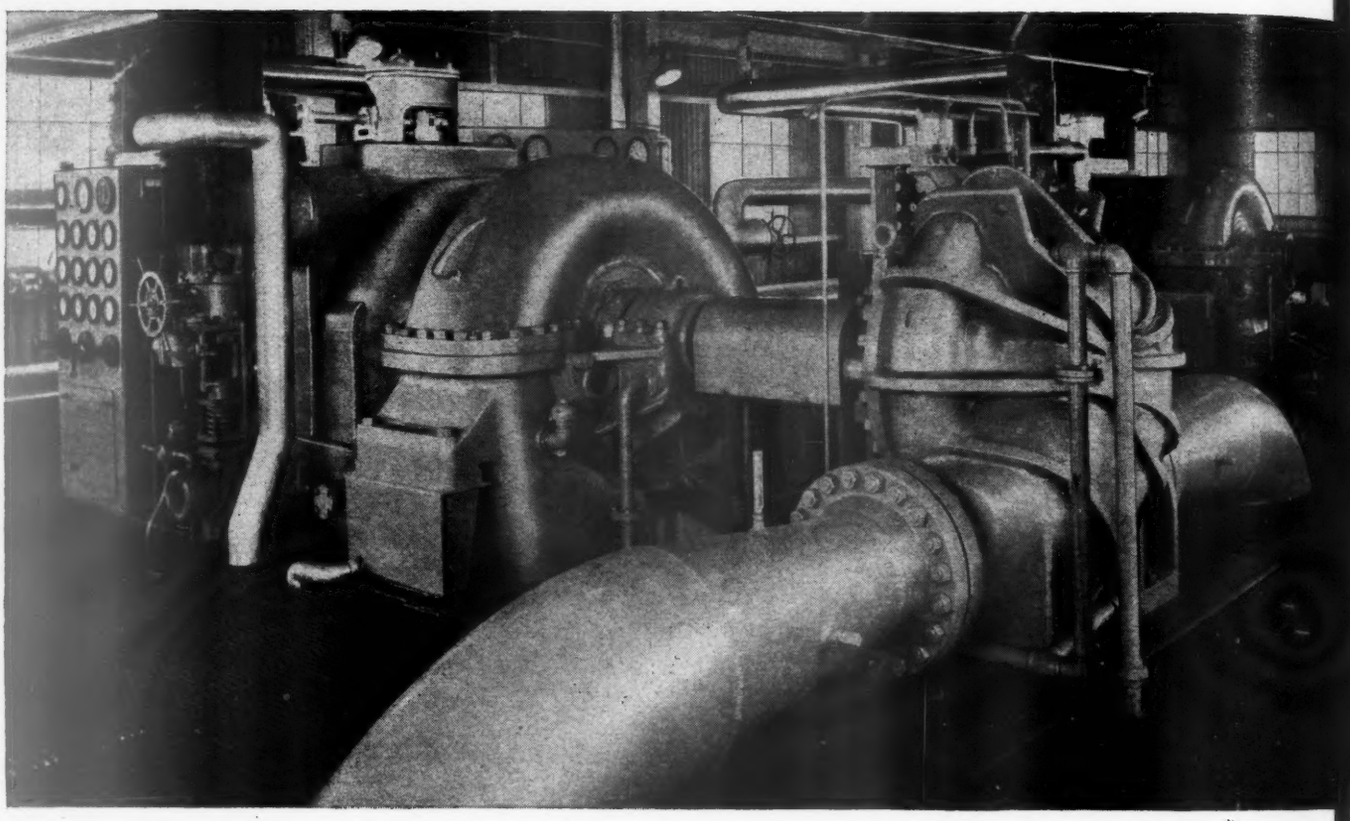
EXCLUSIVE

Structure

North Dakota covers the larger part of the Williston Basin, a regional syncline that extends into Manitoba, Saskatchewan, Montana, and South Dakota, and which has its deepest point in Dunn County, southwest of Williston, North Dakota. Regionally, the basin rises gradually toward the pre-Cambrian shield area in Minnesota and rises more rapidly toward the Montana plains in the west. The large Cedar Creek or Baker-Glendive fold of southeastern Montana extends into the southwest corner of North Dakota in Bowman County. The north-south trending Nesson anticline in southern Williams and northern McKenzie counties is the only large closed surface structure discovered within the state, and other smaller structures are known. Gentle folding

NEW COMPRESSOR

Now in Operation on Tra



"I-R PACKAGED" steam turbine-driven centrifugals permit important savings in foundation and installation costs

TRANSCONTINENTAL GAS PIPE LINE CORP., Houston, is now pumping gas on its new 1840-mile pipeline from Texas to the Eastern Seaboard. The 30" line extends from the lower Rio Grande Valley to 134th Street, New York City.

At Station Five in Eunice, La., which was designed and built by Fish Engineering Corporation, two Ingersoll-Rand steam turbine-driven centrifugal compressors are already operating while a third unit is on order. These machines represent a new development in gas pipeline compressing. They are completely self-contained "packaged units" consisting of a steam turbine and a centrifugal compressor mounted directly on a surface-type steam condenser.

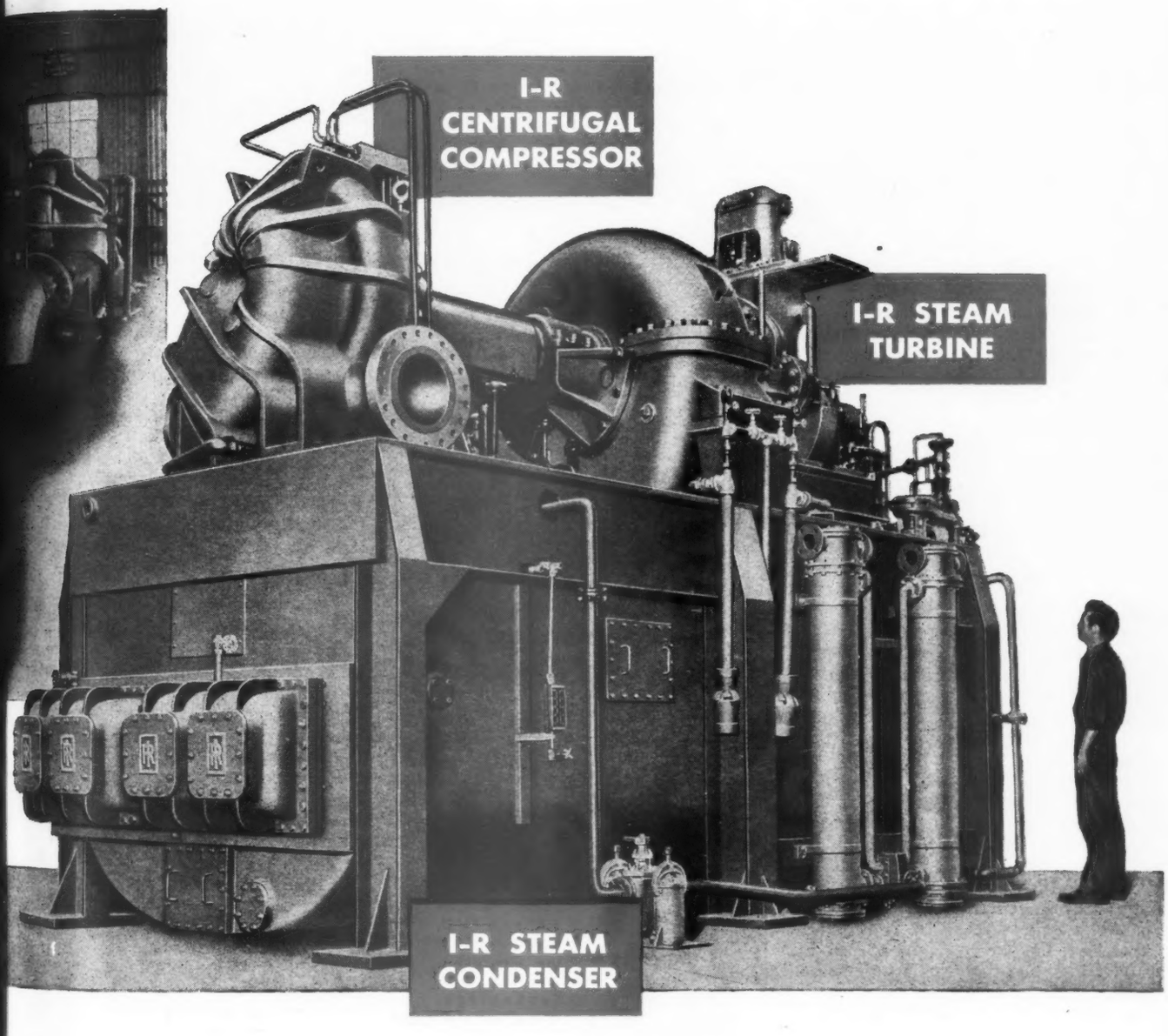
The entire unit, including the condensate pumps and ejectors, was designed and built by Ingersoll-Rand. This packaged construction has permitted substantial savings in foundation costs and in the time and expense required for installation.

The three I-R centrifugals, arranged in series, will handle 465 million cubic feet of gas per day and boost the pressure from station intake of 470 psig to full line pressure of 800 psig. Ingersoll-Rand 4370 hp turbines drive the blowers at 4700 rpm. The Ingersoll-Rand steam condenser, which contains 4600 square feet of condensing surface is designed with special structural steel bracing to provide a foundation for the turbine and blower.

If you have not decided which type of compressor you need—centrifugal or reciprocating—your I-R representative is a good man to have helping you. Ingersoll-Rand has over 80 years of experience in designing and building reciprocating compressors for all types of service. I-R has also been designing and building centrifugal compressors for over 40 years. Call your Ingersoll-Rand representative when you want help and advice.

DEVELOPMENT

Transcontinental's 1840-Mile Pipeline



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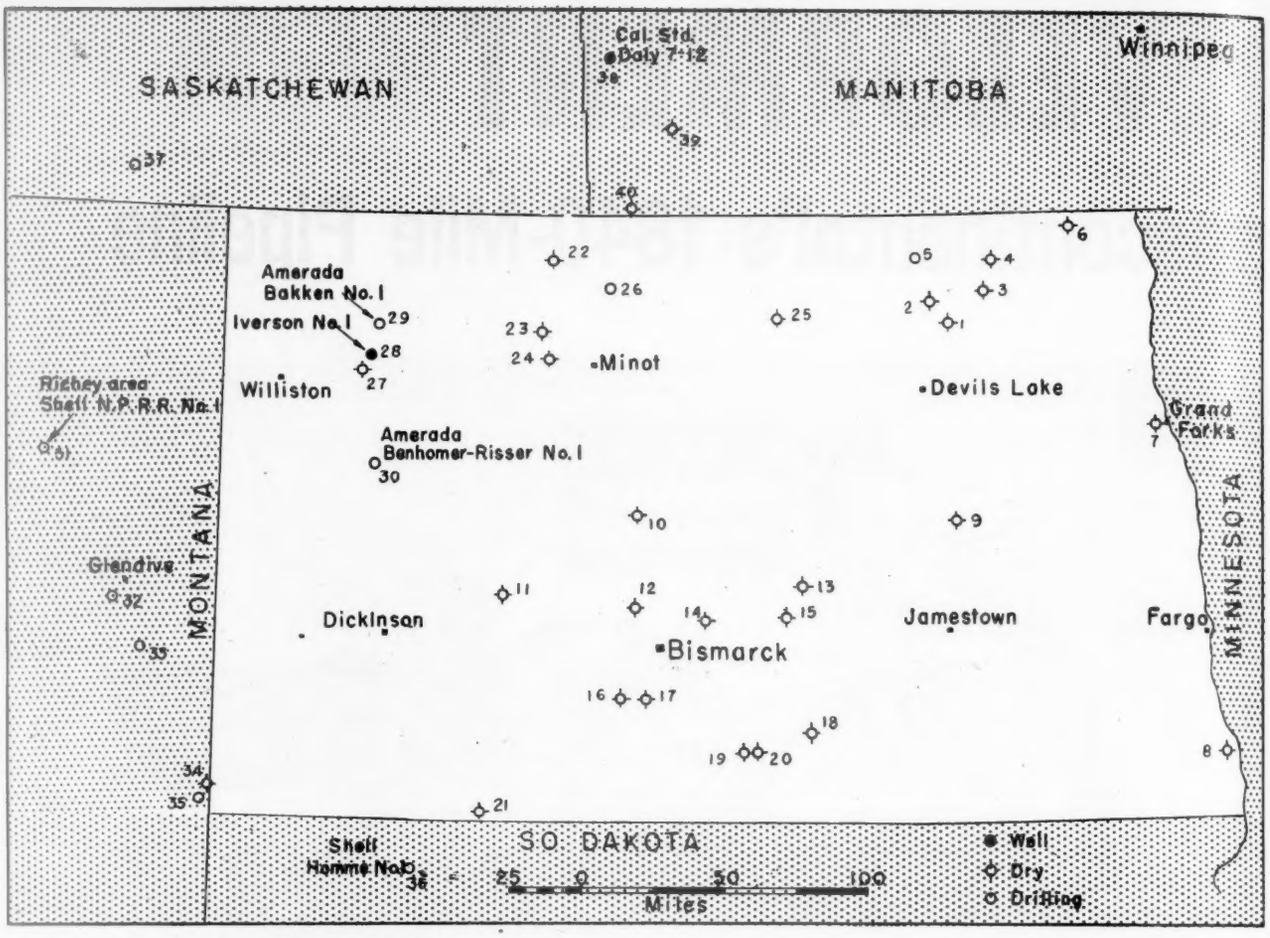


FIG. 1. Significant tests for oil and gas in North Dakota and surrounding areas. The wells are listed in Table 1.

with some possible local closure is observable in the Upper Cretaceous Fox Hills beds in Emmons and southern Morton counties. The Roeser and Pendleton Weber No. 1 well near Linton in Emmons county was drilled on a surface high after geophysical work in the area. Scant subsurface information suggests a north plunging nose on the Dakota sandstone there. Structural contours on the top the Dakota sandstone suggest other possible areas of flattening or folding, but present control is insufficient to prove major folding. Geophysical anomalies have been reported in many areas. The Dakota sandstone rises 3500 ft between the Nesson anticline and Grand Forks, and the granite basement rises at least 12,500 ft. Much of the apparent simplicity of North Dakota structure is due to lack of information. Pleistocene drift effectively covers much of the state, and large areas that were not glaciated have non-marine Tertiary beds at the surface. Major unconformities at the base of the Devonian, Upper Mississippian, Triassic, and Jurassic may effectively hide structure in the rocks below. For these reasons an adequate discussion of the state's structural geology must await further development.

Stratigraphy

General. North Dakota is underlain by a thick sequence of sedimentary rocks. They are mostly marine, and all the systems of the geologic column have been reported except the Cambrian, Pennsylvanian, and Permian.

The rock column may be divided vertically into several large segments of similar aspect. The pre-Cambrian granites and gneisses are overlain unconformably by the gray and green shales and the quartzose sandstones of the Ordovician Winnipeg formation. Those rocks are overlain in apparent conformity by a thick section of carbonate rocks with minor sandstone and shale that comprises the rest of the Ordovician and Silurian systems.

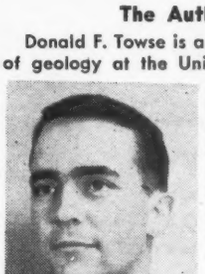
There is a widespread unconformity at the top of the Silurian system, and lying above that unconformity is another thick section of carbonates, the Devonian system. Minor amounts of evaporites and shales are present. Regional studies indicate unconformity at the top of the Devonian over much of the state, but the lithologic break that is most apparent in that part of the section is at the top of the sequence of dark shales and limestones called the Englewood formation at the base of the Mississippian system.

The Madison group above the Englewood is predominantly limestone and dolomite, and it grades upward into the carbonates and anhydrite of the Charles formation. The Big Snowy group above the Charles is a heterogeneous sequence of dark and colored shales, evaporites, carbonates, and small amounts of sandstone. The dark shales of the Heath formation at the top of the group provide a sharp contrast to the dolomites and pale colored shales of the upper Mississippian Amsden formation.

Lying unconformably upon the Amsden are the red beds that make up the

The Author

Donald F. Towse is assistant professor of geology at the University of North Dakota, Grand Forks, North Dakota. He holds S.B. and Ph.D. degrees from the Massachusetts Institute of Technology, where he specialized in petroleum geology and sedimentology and was a teaching fellow and assistant to Dr. Robert R. Shrock.



Towse did surface and subsurface geologic work in Wyoming, Colorado, and South Dakota while a geologist with Amerada Petroleum Corporation, and was appointed to his present position in June, 1951. He is at present studying the subsurface stratigraphy of North Dakota for the North Dakota Geological Survey and teaching sedimentology, petroleum geology, and paleontology at the University.

TABLE 1. TESTS FOR OIL AND GAS

1. Union Aanstad No. 1, 29-158n, 62w, Pembina County, North Dakota. Completed 1949, D&A, strat test.
2. Union Skjervheim No. 1, 28-159n, 63w, Cavalier County, North Dakota. Completed 1951, D&A, TD 3409, tight hole.
3. Union Wohletz No. 1, 32-160n, 60w, Cavalier County, North Dakota. Completed 1951, D&A, TD 2765, tight hole.
4. Union Ellis-U. C. L. I. No. 1, 12-161n, 60w, Cavalier County, North Dakota. Completed 1951, D&A, TD 2271, tight hole.
5. Union-Los Nietos Restad No. 1, 26-162n, 64w, Cavalier County, North Dakota. Drilling 10-1-51.
6. Turner Gapp No. 1, 7-163n, 55w, Pembina County, North Dakota. Completed 1951, D&A.
7. Red River Berg No. 1, 35-152n, 51w, Grand Forks County, North Dakota. Completed 1951, D&A, TD 2051, top of pre-Cambrian at 520 feet.
8. Snowden Ruddy Bros. No. 1, 11-132n, 48w, Richland County, North Dakota. Completed 1948, D&A, TD 695 in pre-Cambrian.
9. Glenfield Oil No. 1, 18-146n, 62w, Foster County, North Dakota. Completed 1928, D&A, TD 3240 in pre-Cambrian.
10. Samedan Hanson No. 1, 10-146n, 81w, McLean County, North Dakota. Completed 1950, D&A, TD 9032.
11. Kelly-Plymouth Lentz No. 1, 28-142n, 89w, Mercer County, North Dakota. Completed 1950, D&A, TD 12,526, North Dakota's deepest well.
12. Carter Semling No. 1, 18-141n, 81w, Oliver County, North Dakota. Completed 1942, D&A, TD 8850 in pre-Cambrian.
13. Townley Robinson No. 1, 12-142n, 72w, Kidder County, North Dakota. D&A TD 2400.
14. Continental-Pure Davidson No. 1, 6-140n, 77w, Burleigh County, North Dakota. Completed 1949, D&A, TD 6957 in pre-Cambrian.
15. Magnolia Dakota "A" No. 1, 36-141n, 73w, Kidder County, North Dakota. Completed 1950, D&A, TD 5609 in pre-Cambrian.
16. Carter strat test, 22-136n 83w, Morton County, North Dakota. Completed 1940, D&A, TD 4930.
17. Phillips-Carter Dakota No. 1, 29-136n, 81w, Morton County, North Dakota. Completed 1951, D&A, TD 7790 in pre-Cambrian.
18. D. J. Carter No. 1, 26-134n, 72w, Logan County, North Dakota. Completed 1933, D&A, TD 2284.
19. Roeser and Pendleton Weber No. 1, 35-133n, 76w, Emmons County, North Dakota. Completed 1950, D&A, TD 5556 in pre-Cambrian.
20. Northern Ordnance Franklin Investment No. 1, 35-133n, 75w, Emmons County, North Dakota. Completed 1943, D&A, TD 5359 in pre-Cambrian.
21. Davis well, 17-129n, 91w, Adams County, North Dakota. Completed 1923, D&A. TD 2800.
22. A. R. Jones Gehrenger No. 1, 17-161n, 84w, Renville County, North Dakota. Completed 1931, D&A, TD 3872.
23. Price Drilling Kline No. 1, 16-157n, 85w, Ward County, North Dakota. Completed 1949, D&A, TD 8435.
24. DesLacs Blum No. 1, 4-155n, 85w, Ward County, North Dakota. Completed 1923, D&A, TD 3980.
25. Ajax Bell No. 1, 28-158n, 72w, Pierce County, North Dakota. Completed 1951, D&A, TD 5383.
26. California Thompson No. 1, 31-160n, 81w, Bottineau County, North Dakota. Drilling 10-1-51.
27. California Kamp No. 1, 3-154n, 96w, Williams County, North Dakota. Completed 1938, D&A, TD 10,281.
28. Amerada C. Iverson No. 1, 6-155n, 95w, Williams County, North Dakota. Completed 1951. Flowed 290 bopd from upper Devonian, TD 11,954 in the Silurian.
29. Amerada Bakken No. 1, 12-157n, 95w, Williams County, North Dakota. Drilling 10-1-51. Had a commercial oil show in Madison ls.
30. Amerada Benhomer-Risser No. 1, 12-149n, 96w, McKenzie County, North Dakota. Drilling 10-1-51.
31. Shell NPRR No. 1, Richey area, Dawson County, Montana, 19-23n, 50e. Drilling 10-1-51. Flowed 38° oil in Charles formation. Ordovician test.
32. Texas NPRR No. 1, 35-15n, 54e, Dawson County, Montana. Drilling 10-1-51. Devonian test.
33. Shell Fee No. 1, 30-12n, 57e, Pine unit, Wibaux County, Montana. Drilling 10-1-51. Devonian test.
34. Carter NPRR No. 1, 19-4n, 62e, Fallon County, Montana. Completed 1941, D&A, TD 9690 in pre-Cambrian.
35. Texas Pacific-Pure Cox No. 1, 23-3n, 61e, Fallon County, Montana. Drilling 10-1-51. Ordovician test.
36. Shell Homme No. 1, 13-20n, 12e, Perkins County, South Dakota. Drilling 10-1-51.
37. Shell Big Muddy Lake No. 1, 12-3n, 21w2, Saskatchewan. Drilling 10-1-51.
38. California Standard Daly 7-12, 12-10n, 28wpm, Virden, Manitoba. Completed 1951, p. 20-25 bopd 33° from the Madison limestone at 2247-2363 feet.
39. California Standard Hartney 16-33, 33-5n, 24wpm, Manitoba. Completed 1950, D&A, TD 5138.
40. Souris Valley Downey No. 1, 9-10n, 27wpm, Manitoba. Completed 1951, D&A. Show in Madison.

Drilling Wells Not Shown On Map

Amerada Dilland No. 1, 31-156n, 95w, Williams County, North Dakota. Drilling 10-1-51. Outpost, Beaver Lodge pool.

Tioga M. Iverson No. 1, 18-155n, 95w, Williams County, North Dakota. Drilling 10-1-51. Outpost, Beaver Lodge pool.

Triassic system and the lower part of the Jurassic. Evaporites are common. A major unconformity is at the base of the Jurassic system. In places the entire Triassic system is absent, but the similarity of the lithology and the reworked Triassic sediments in the basal part of the Jurassic sequence make determination of the boundary between the Jurassic and Triassic difficult and often impossible. Some Permian red beds may be present in the state, but their similarity to the overlying Triassic makes identification difficult.

The Jurassic red beds and the overlying marine sequence of limestone, shale, and sandstone are named the Ellis group. The non-marine Morrison formation separates the Ellis from the thick Cretaceous gray shale sequence. The sandstones of the Dakota group lie at the base of the Cretaceous system, and the monotonous gray shale is interrupted only by the thin Muddy sand, the Greenhorn limestone, and the calcareous Niobrara formation. The silts and sands of the Fox Hills lie at the top of the marine Cretaceous section.

The non-marine sands, shales, and the abundant coals that are typical of the uppermost Cretaceous and the Tertiary system lie above the Fox Hills. The Cannonball member of the Ludlow formation represents a late marine incursion of short duration.

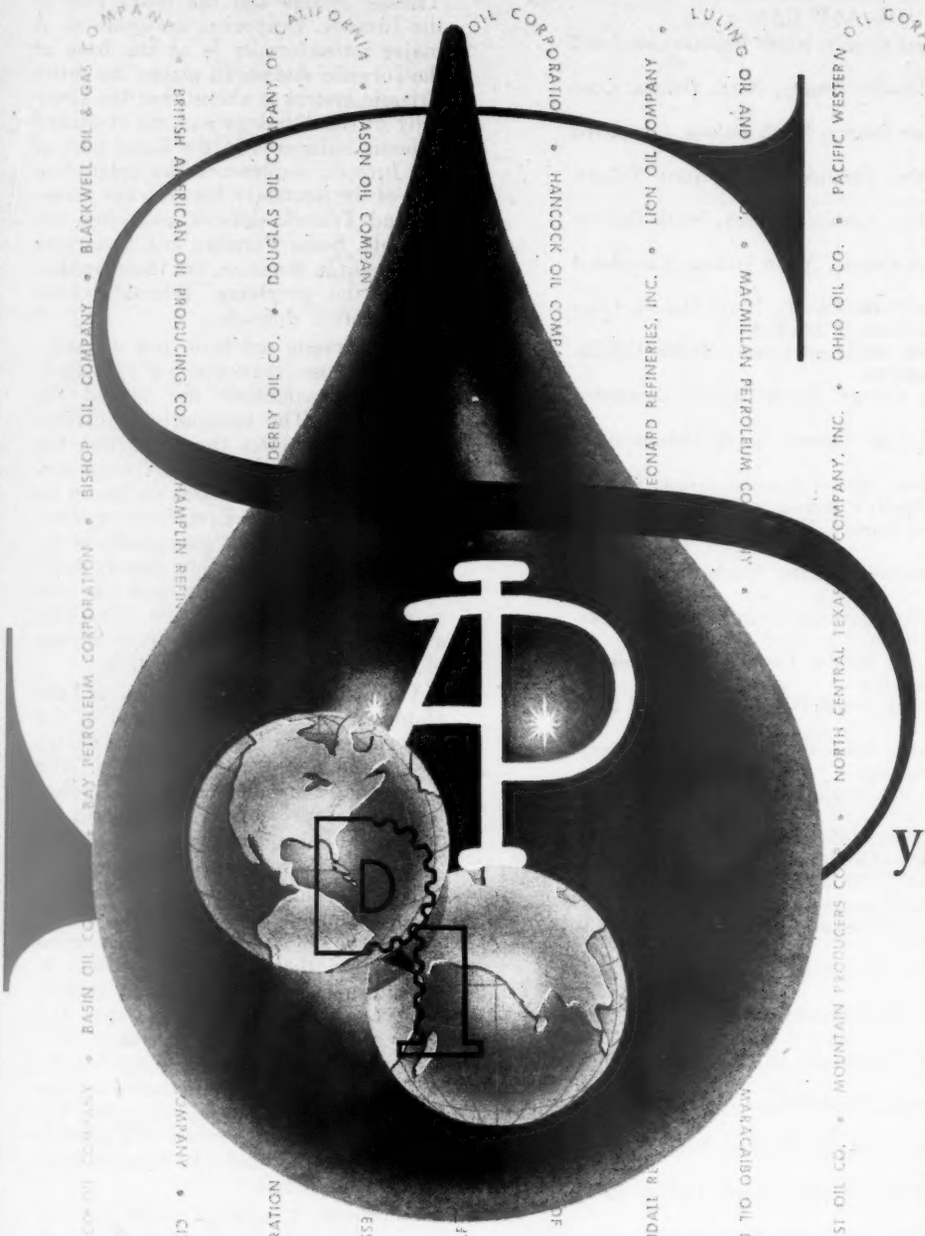
Nomenclature and age of lithologic units. The oldest rocks exposed in the state belong in the upper part of the Benton shale. The older rocks must necessarily, therefore, be identified in the subsurface by surface and subsurface correlation from outcrops and wells in Manitoba, Montana, and South Dakota. The correlation and age assignments as given in this discussion are believed to be substantially correct, but further drilling in the state will provide nicer correlation and will require some changes in detail.

Cambrian. Cambrian rocks are not known definitely in the state, but they have been penetrated in southeastern Montana, and the Cambrian Deadwood formation crops out in the Black Hills. Some Cambrian rocks may underlie the southwestern part of the state.

Ordovician. Ordovician rocks lie on the pre-Cambrian basement over most of the state, except in the extreme southeastern part. The system may be divided into three formations, in ascending order, the Winnipeg, Red River, and Stony Mountain formations. The terminology is derived from Manitoba. Early Ordovician time is probably not represented.

The Winnipeg formation consists of gray and greenish gray splintery shale and medium to coarse grained quartzose to glauconitic sandstones. Much of the sandstone has good porosity. Small amounts of limestone and arkose are sometimes present. Thickness varies between 100 and 535 ft, and the amount of sandstone increases in an easterly direction.

The Red River formation is 100 to



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600 ft thick, and it consists largely of white to very pale orange to pinkish gray limestone and dolomite. The lower part of the formation is more shaley, and the upper part is fragmental and porous.

The Stony Mountain formation is medium gray dense limestone, and it is shaley and cherty. Thickness is 100 to 500 ft. A persistent bryozoan zone occurs in the middle of the formation.

Silurian.—The Silurian Stonewall formation is present over most of the state, and its thickness varies from 0 to 300 ft. The Silurian has long been known in Manitoba. Recent drilling in southern North Dakota has revealed a section of rock that is correlated with the undoubted Silurian of Manitoba and the northern part of the state on the basis of similarity of lithology and stratigraphic position. The Stonewall is very pale red, pinkish gray, very pale yellow, or very pale brown dolomite and limestone. Small amounts of sandstone, colored shale, and anhydrite are present. In many places the top of the formation contains abundant coarse round frosted quartz sand grains and many solution holes. The upper part of the formation also contains lateritic red shaley material and some solution breccia. There is an unconformity at the top of the formation. The Stonewall thins to the south, east, and west, and is missing in some places.

Devonian. Middle Devonian rocks are present over much of the state, and it is believed that Upper Devonian was penetrated by the wells on the Nesson anticline. The Middle Devonian consists of pinkish and light gray to pale brown, granular to fine grained limestone and dolomite. The upper part is granular, porous, and vuggy. A thick section of salt penetrated in Amerada's Iverson No. 1 well is believed to mark the top of the Middle Devonian. That well penetrated 1175 ft of yellowish brown to brownish gray limestone with some reddish orange and medium gray shale that is assigned to the Upper Devonian. The Devonian system varies from 0 to 1740 ft in thickness. It thins to the west and south and is absent in the eastern part of the state. Correlation within the Devonian sequence is difficult, and the tracing of formations must await further drilling.

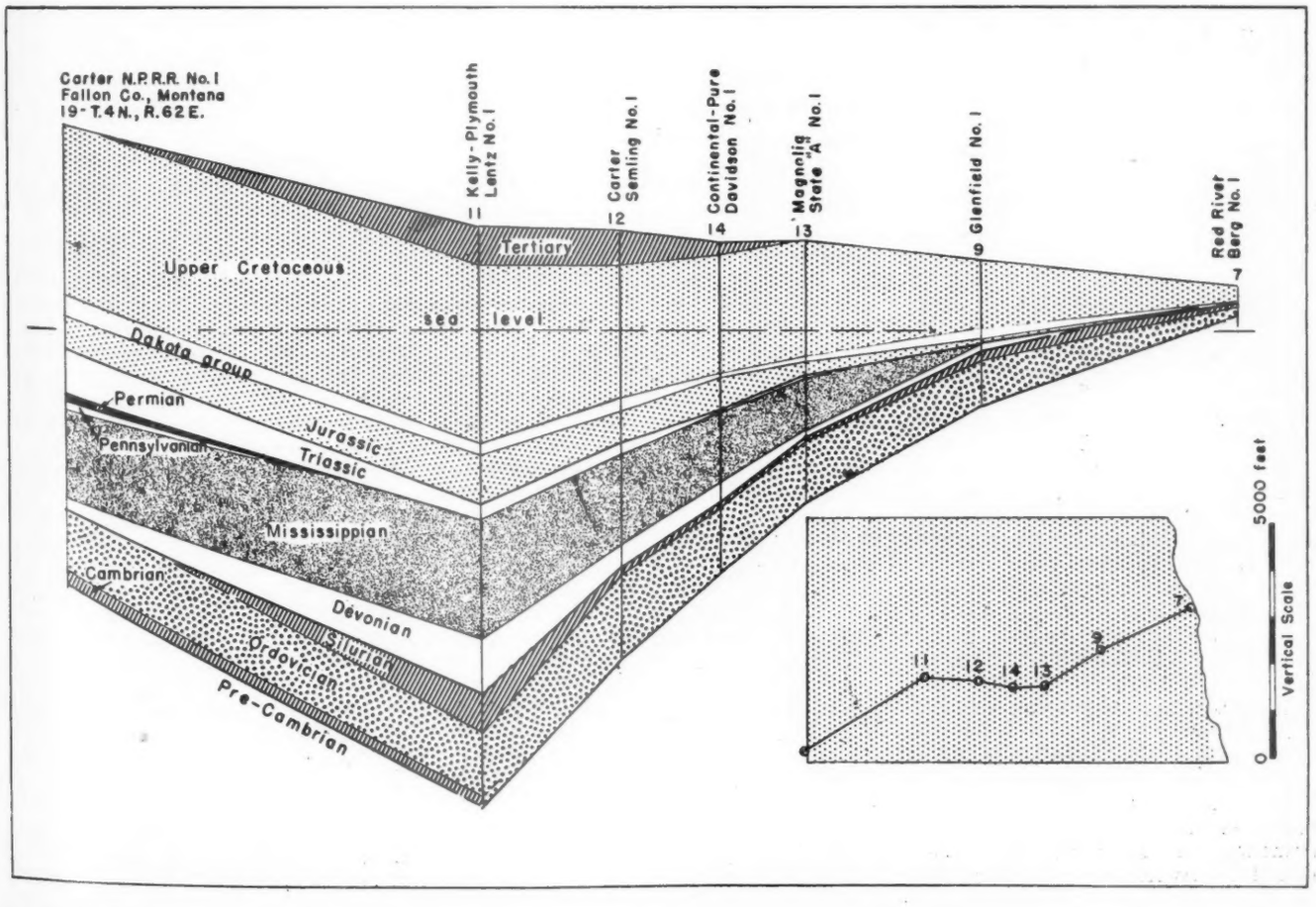
Mississippian. The Englewood formation is at the base of the Mississippian system. It is from 25 to 110 ft thick and consists of dark gray carbonaceous shale, gray limestone, and some siltstone. It is Kinderhookian in age and is conspicuously radioactive on gamma ray logs.

The Madison group overlies the Englewood formation. It is correlated with the well known Madison group of Montana. The group may be divided into the Lodgepole and Mission Canyon formations on the surface, but in the North Dakota subsurface such a division is difficult. The group varies from 0 to 1565 ft in thickness and consists of light gray, very pale orange, and very pale yellowish brown limestone and dolomitic limestone. Grays predominate in the lower part. Porosity is variable, but the upper part is generally more porous. Brachiopods are common, and chert and gray shale are more common in the basal part. The group is thickest in the northwest part of the state, and it is absent in the east.

The Madison group is overlain by the Big Snowy group. The Big Snowy has been divided into four formations, which, in ascending order, are the Charles, Kibbey, Otter, and Heath formations. The Charles formation varies from 0 to 890 ft, and it consists of pale yellowish brown, brownish gray, light gray, and olive gray limestones and dolomites and much anhydrite. The carbonates are fine grained to finely fragmental and have some porosity. The Charles appears to be an anhydritic facies partly correlative with the Madison in other places. It thins to the south and east and is absent in the eastern part of the state. It is generally separated from the Madison below on the basis of its anhydrite content, but exact correlation is difficult due to the apparent facies change.

The Kibbey formation consists of silty olive colored sandstone, gray and moderate brown shales, and reddish dolomite, and it has small amounts of anhydrite and limestone. Its dark shales contrast with the pale limestones of the underlying Charles formation. The Kib-

FIG. 2. East-west structural and stratigraphic cross-section of North Dakota.



bey varies from 0 to 350 ft in thickness. Exact correlation is difficult in the Big Snowy group above the Charles formation.

The Otter formation is 0 to 310 ft thick and consists of gray, greenish gray, and moderate brown shales. Anhydrite is common, and limestone is sometimes present.

The Heath formation is distinguished by its black, flaky, fine carbonaceous shale. Brown shale, light brown dolomite, and small amounts of anhydrite are also included in the formation. Gamma ray logs show high gamma activity in the formation.

The Amsden formation lies above the Big Snowy group. The Amsden is considered as Mississippian in age in this report, but the age of the formation is a cause for controversy, and the age designation must be considered as tentative. The Amsden consists of pale red, light brown, and olive gray dolomite and light to moderate brown shale. Some medium grained porous sandstone is present. Thickness varies from 0 to 250 ft, and the Amsden is absent in the eastern and the extreme southern part of the state.

Pennsylvanian.—The Pennsylvanian Minnelusa formation is present on the Cedar Creek anticline and in South Dakota, but Pennsylvanian rocks have not been found in North Dakota. The Minnelusa formation may extend into the southwestern part of the state. All or part of the beds assigned to the Amsden may be Pennsylvanian in age.

Permian. Undoubted Permian rocks have not been penetrated in North Dakota, but the Permian Minnekahta and Opeche formations are known in South Dakota and on the Cedar Creek anticline. Permian rocks may be found in the southwestern part of the state.

Triassic. The Triassic Spearfish formation is present over the western half to two-thirds of the state, and it varies from 0 to 895 ft in thickness. It consists of moderate brown to light brown silty shale and moderate brown to reddish orange sandstone. Gypsum and anhydrite are common. The lithology of the Spearfish is similar to that of the underlying Opeche, so that discrimination of Permian Opeche rocks may be difficult. Sandstones become less numerous as the Spearfish is traced eastward.

Jurassic. The Jurassic system is divided into a lower Ellis group and an upper Morrison formation. The Ellis group in Montana has further been divided into, in ascending order, the Sawtooth, Rierdon, and Swift formations. The Sawtooth may be discriminated in North Dakota, but the Rierdon and Swift formations are difficult to identify. The interval of the Rierdon and Swift formations is herein called upper Ellis.

The Sawtooth formation has at its top a very pale orange to white limestone that is usually coarsely fragmental to oolitic and quite porous. Limestone occurs in the upper two-thirds of the formation, and some moderate brown shale and anhydrite may be present. The lower part of the formation consists of gray to moderate brown shale and abundant anhydrite or gypsum. The contact with the underlying Spearfish appears gradational, and the base of the Sawtooth certainly is made of reworked Spearfish sediment.

The upper Ellis consists of greenish gray and yellowish green shales and brown to glauconitic sandstones. Some of the sandstones are quite porous. The sandstones become less important as the formation is traced eastward. The Ellis group varies from 90 to 895 ft thick. There is a major unconformity at its base, and from west to east it progressively overlaps Mississippian, Devonian, Silurian, and Ordovician sediments.

The Morrison formation lies above the Ellis group and below the Lower Cretaceous Dakota group. The Morrison consists of light brown to light gray or greenish gray shale, and it contains small amounts of bentonite and shaley sandstone. The formation is 0 to 260 ft thick; it thins in an easterly direction; and it is absent in the eastern part of the state. The Morrison is in some places difficult to separate from the underlying Ellis.

TABLE 2. Formations in North Dakota.

TERTIARY	Oligocene	White River formation
	Eocene	Golden Valley formation
	Paleocene	Tongue River formation Cannonball-Ludlow formation
CRETACEOUS	Montana group	Hell Creek formation Fox Hills formation Pierre shale
	Colorado group	Niobrara formation Benton formation Greenhorn limestone Muddy sand
	Dakota group	Dakota sandstone Fuson shale Lakota formation
JURASSIC	Ellis group	Morrison formation Upper Ellis Sawtooth formation
TRIASSIC		Spearfish formation
PERMIAN		Minnekahta formation Opeche formation
PENNSYLVANIAN		Minnelusa formation
MISSISSIPPIAN	Big Snowy group	Amsden formation Heath formation Otter formation Kibbey formation Charles formation
	Madison group	Mission Canyon formation Lodgepole formation
	Kinderhook	Englewood formation
DEVONIAN	Upper Devonian	Lyleton formation
	Middle Devonian	Manitoban formation Winnipegosan formation Elm Point formation Ashern formation
SILURIAN		Stonewall formation
ORDOVICIAN		Stony Mountain formation Red River formation Winnipeg formation
CAMBRIAN		Deadwood formation
PRE-CAMBRIAN		Gneiss and Granite

Lower Cretaceous. The Dakota group lies above the Morrison formation, and, if it correlates with the Inyan Kara group of the Black Hills, it is Lower Cretaceous in age. The Dakota group may transgress time divisions, however, and the age assignment must remain tentative. The Dakota group may, in the northwestern part of the state, be divided into, in ascending order, the Lakota formation, the Fuson shale, and the Dakota sandstone. The Lakota formation is a medium to coarse to conglomeratic porous quartz sandstone. The Fuson shale is medium gray or light brown and greenish gray. The Dakota sandstone is medium to fine grained and may be micaceous, shaley, and tight. In many places the Dakota group has sandstone developed throughout its entire thickness; and, although the sandstones grade from finer at the top of the group to coarser at the bottom of the group, and shales divide the sandstone beds within the group, no clear tripartite division is possible. The porosity is quite variable in the Dakota group sandstones, and the sandstones may vary from unconsolidated to quite well cemented by pyrite or calcite. The group

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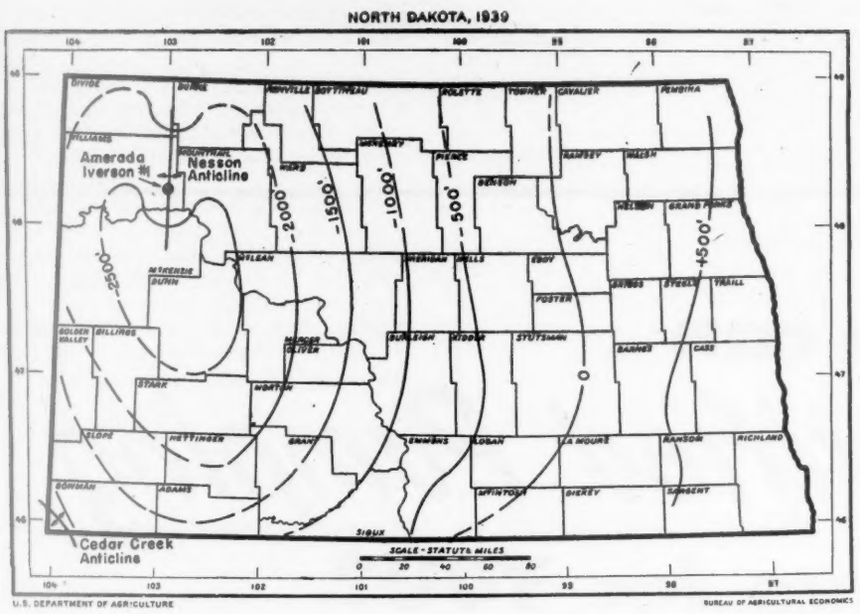

FIG. 3. Structural map of North Dakota. 500 ft contours drawn on the top of the Dakota sandstone. Datum is mean sea level.

is easily separated from the Benton shales above and the Morrison formation below.

Upper Cretaceous. The base of the Upper Cretaceous is arbitrarily placed at the top of the Dakota group, although it is realized that the time division may lie above that horizon. If the Muddy sand of North Dakota is correlative chronologically with the Newcastle sand of the Black Hills, then the boundary of the upper and lower Cretaceous lies above the Muddy sand in North Dakota, 200 ft or more above the Dakota group. Muddy sand is absent in much of the state, however, so top of the Dakota group is taken as a mappable boundary.

The Benton formation lies between the Dakota sandstone and the Niobrara shale, and it is 90 to 1360 ft thick. It consists of medium to medium dark gray shale and contains much bentonite. The Muddy sand is a thin (0 to 40 ft) fine grained, poorly sorted quartz sandstone that lies about 200 ft above the top of the Dakota group and within the Benton shale. Porosity has been poor in wells drilled to date, and the sand is missing thus far in the eastern two-thirds of the state. The Greenhorn limestone is 30 to 150 ft thick, and it lies within the Benton shale about 650 ft above the top of the Dakota group. The Greenhorn consists of very calcareous white speckled shale and fine to medium grained white to yellowish gray fragmental limestone. Foraminifera are locally present.

The Niobrara formation is 80 to 215 ft thick and lies above the Benton formation. It is medium to medium light gray very calcareous shale with white or flesh colored calcareous specks. Foraminifera are locally abundant. The top is picked at the first calcareous specks, but the base is difficult to determine consistently. The Benton formation below is usually darker in color; not calcareous.

The Pierre shale is a thick shale sequence between the Niobrara formation below and the Fox Hills sandstone above. Its thickness varies from 930 to 2300 ft. The Pierre consists of medium light to light gray, olive gray, and greenish gray shale, and there are many bentonite beds and some calcareous concretions and siltstones. More study of the Pierre shale may result in a workable subsurface subdivision. The Pierre is more bentonitic toward the base, and "fullers earth" beds can be seen in the basal part at the surface.

The Fox Hills formation lies above the Pierre shale and is 180 to 320 ft thick. It crops out in the south central part of the state. The Fox Hills consists of light olive gray shaley to glauconitic sandstones and yellowish brown to moderate brown sandy shale. The sandstones are lenticular in part.

The Hell Creek formation is the uppermost Cretaceous formation, and it is nonmarine except for the thin Brien sandstone member at its base. The Hell Creek consists of fine shaley sandstone, lignite, and coaley shales and is 100 to 575 ft thick.

Tertiary. The Paleocene Fort Union rocks are above the Hell Creek formation, and they have been divided into two formations, the Cannonball or Ludlow at the base and the Tongue River formation at the top. The Cannonball and Ludlow formations are a transitional marine-nonmarine sequence. The fossiliferous marine sandstones and greenish gray to medium gray shales of the Cannonball extend from the Missouri River to the Little Missouri River in Slope County, where they interfinger and disappear among the olive gray shales, lignite, and nonmarine sandstones of the Ludlow formation. The Ludlow is 0 to 250 ft thick.

The Ludlow is overlain by the light to olive gray partly calcareous shales, fine to coarse grained yellowish gray to light brown sandstones, and the thick lignites of the Tongue River formation. The Tongue River formation is 200 to 800 ft in thickness and is the main lignite formation in western North Dakota. It covers much of the western part of North Dakota and the eastern part of Montana.

The Eocene Golden Valley formation, a sequence of light colored clay, fine micaceous sandstones, and ashstone, overlies the Tongue River formation. In scattered localities the Oligocene White River formation is found as cap rock on the higher buttes. It contains 50 to 200 ft of river and lake deposits.

Pleistocene glacial sediments cover much of the eastern and northern part of the state.

Summary. North Dakota was a region of marine sedimentation during much of the geologic past. Carbonates were deposited over most of the state in the early Paleozoic, and in the medial Paleozic there was carbonate deposition during parts of the Silurian and Devonian periods. The Upper Devonian sediments are localized in the northern and northwestern part of the state. The Madison group was deposited over most of the state, but the Big Snowy group may have been restricted to the deeper parts of the basin. A period of uplift in the east and tilting to the west in pre-Jurassic time stripped sediments from the eastern part of the state, and Jurassic overlap placed the Sawtooth formation unconformably over older rocks, until in the eastern part of North Dakota the Jurassic overlies Ordovician. During the Late Cretaceous the state was again the site of an important basin of deposition, and during the Tertiary the western part of the state continued to receive sediments.

Important unconformities are at the base of the Ordovician, the top of the Ordovician, the top of the Silurian, the top of the Devonian, the base of the Big Snowy group, the base of the Triassic, and the base of the Jurassic system.

Development

Wildcatting in North Dakota began as early as 1923, but the era of modern development began with the drilling of the California Company's Nels Kamp No. 1 well on the Nesson anticline in 1938. The structure was described as early as 1918 by A. J. Collier in U. S. G. S. Bulletin 691. The anticline is apparent in the dips in the surface Tongue River formation, but contour structure mapping is often unsatisfactory due to the difficulties in correlation of lignite beds between outcrops. The first well to be drilled on the anticline was the Big Viking Oil Company's well 40 acres south of the California well. The Big Viking well was abandoned in 1935 at a depth of 4642 ft in the Jurassic Morrison formation. The California Company did seismic work in the area and drilled the Kamp No. 1 to a total depth of 10,281 ft in the Upper Devonian before drill pipe became stuck and the hole was abandoned in 1938.

The Carter Oil Company drilled a strat test to the Big Snowy in Morton

County in 1940, and the Carter Semling No. 1 basement test in Morton County was drilled in 1942.

Exploratory drilling was resumed seriously in 1949, and Carter, Phillips, Magnolia, Continental, and others have drilled deep dry holes in the south central part of the state. The Union Oil Company of California drilled the Aanstad No. 1 strat test north of Devils Lake in 1949. Additional geologic information is provided by three shallow basement tests near the eastern border of the state. All three wells were non-technical locations and dry holes.

Small flows of gas have been reported from the Pierre shale in northern North Dakota and southern Manitoba. Natural gas was discovered in the Judith River and Eagle sands of the Pierre shale on the Cedar Creek anticline in southeastern Montana in 1914. The area of gas production on the Little Beaver Dome on the Cedar Creek fold extends into southwestern Bowman County, North Dakota. Non-commercial oil shows had been reported in the state, but North Dakota didn't become an oil producing state until July 19, 1951.

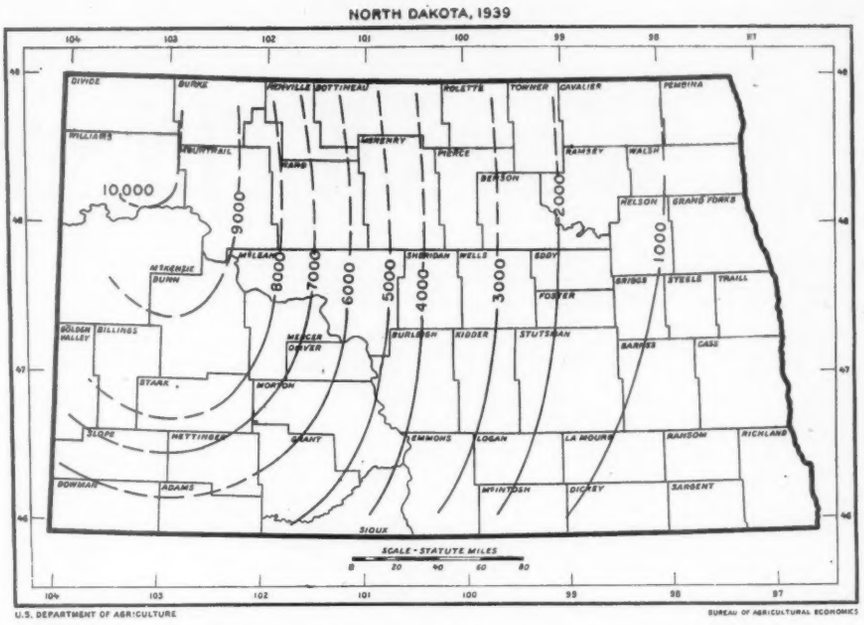

FIG. 4. Isopach map. Total thickness of the rocks between the top of the Dakota sandstone and the Pre-Cambrian basement. 1000-ft contour interval.

Amerada did seismograph work on the Nesson anticline and in September 1950 began drilling the Clarence Iverson No. 1 well in the center of the S. W. ¼ S. W. ¼ of section 6, Township 155 north, Range 95 west. A drillstem test in the first week of January, 1951 made 824 ft of gas cut mud and 1 pint of oil in the Upper Devonian. Early this spring casing was run, and the interval 11,630 to 11,660 ft was perforated and treated with 4000 gal of acid. The well flowed 7,096,000 cu ft of gas per day with a spray of oil. Separator was installed, and the well flowed 307 bbl of light, high gravity oil, large quantities of gas, and 25 bbl of water in 17 hours through ¾ in. choke. Production was from very light gray vugular and Stromatoporoidal Middle Devonian limestone, and gas-oil ratios were excessive. The well was drilled to a total depth of 11,954 ft. Gas was encountered below the light oil zone described above, and medium gravity brown oil and gas were recovered from the Silurian Stonewall formation in the bottom of the hole. The well was plugged back to 10,540 ft, and the Upper Devonian oil zone was perforated from 10,490 to 10,530 ft with 160 holes and acidized with 9000 gal. Initial flow was 290 bbl of 39.8 deg oil per day. The reservoir rock is fractured gray to brownish gray limestone and dolomitic limestone.

The operators had considerable difficulty with lost circulation and stuck drill pipe during the drilling of the well. Present plans are to set casing in the Triassic redbeds and to keep the drilling mud saturated with rock salt so as to prevent solution of the Paleozoic salt sections. The oil now produced has a high paraffin content and a pour point of 80 F. Some difficulty is experienced with producing, storing, and trucking the oil to the railroad, but similar problems have been solved elsewhere. A heated well annulus and heating systems for tanks and trucks will probably be necessary. Time from spudding to final completion was ten and one-half months on the Iverson No. 1, but the operators anticipate that future wells may average six months drilling time. Improvement in drilling and completion practices will make operation and development of the field profitable. Wells are now drilling in the sections to the north and to the south of the discovery well.

The Amerada Bakken No. 1 well on the northern part of the Nesson anticline flowed substantial quantities of 30 deg oil from the Madison limestone this fall. Drilling is continuing, and Amerada is drilling another wildcat on the south end of the anticline in McKenzie County. It is rumored that seismic work has indicated several separate highs on the structure. Amerada and other operators in the region are using mud-logging units in order to avoid overlooking shows of light oil and gas in the generally brownish colored limestones and dolomites.

Elsewhere in the state, the Union Oil Company has drilled three tests north of Devils Lake and is drilling on a fourth. Information on the tests is tightly held by the operator, but the area must be close to the pinchout of the Madison group. It is reported that there are seismograph structures in the area, and magnetic anomalies are known.

The Ajax Oil Company drilled a joint venture with several major companies north of Rugby. No significant shows were encountered, and the well was abandoned in the lower part of the Ordovician Winnipeg formation when it became impossible to recover stuck drill pipe.

The Phillips-Carter Dakota No. 1 well in Morton County was completed as a dry hole in June at a total depth of 7790 ft in pre-Cambrian hornblende gneiss. Information on the well has not been generally released, but oil shows were reported to have been encountered in the Madison limestone and in the Silurian system.

The California Company is beginning to drill the Thompson No. 1 well in Bottineau County.

With commercial shows in the Charles formation in Shell's Richey area well, the Williston Basin in the North Dakota area now has four distinct proven producing zones. These are the Middle Devonian, the Upper Devonian, the Madison limestone, and the Charles formation.

Other wells are said to be planned in the central part of the state. Over much of that area a 6000 ft well would test the entire Paleozoic section.

Seismograph crews are active in the state. A recently announced $200,000 aerial magnetometer survey of the state should do much to high-grade the region for further seismic testing, and information on the region of Devonian and Mississippian pinchout may be obtained.

It is reported that over half of North Dakota has been leased for oil and gas development. Much land title work needs to be done before leases are ready for drilling, but next spring should see a great increase in drilling over most of the state.

Possibilities

North Dakota has a thick section of marine rocks, and four units have demonstrated commercial oil possibilities. Several types of traps are possible in the state. The present production is from a surface anticline, but many hidden and subsurface anticlines may well exist. The many unconformities may also hide suitable structures in underlying rocks, and geophysics and structure drilling must, therefore, supplement surface mapping in the search for anticlines.

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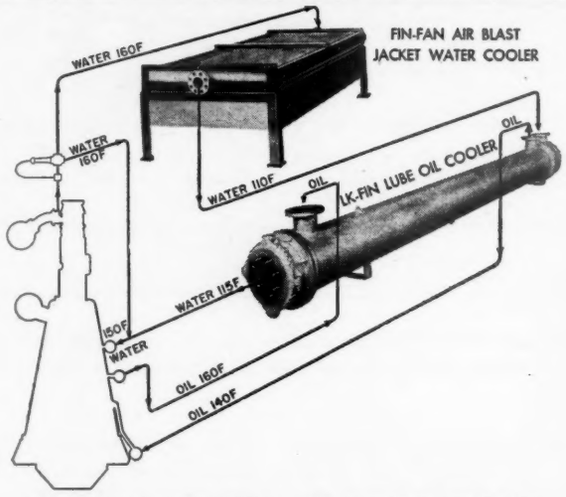

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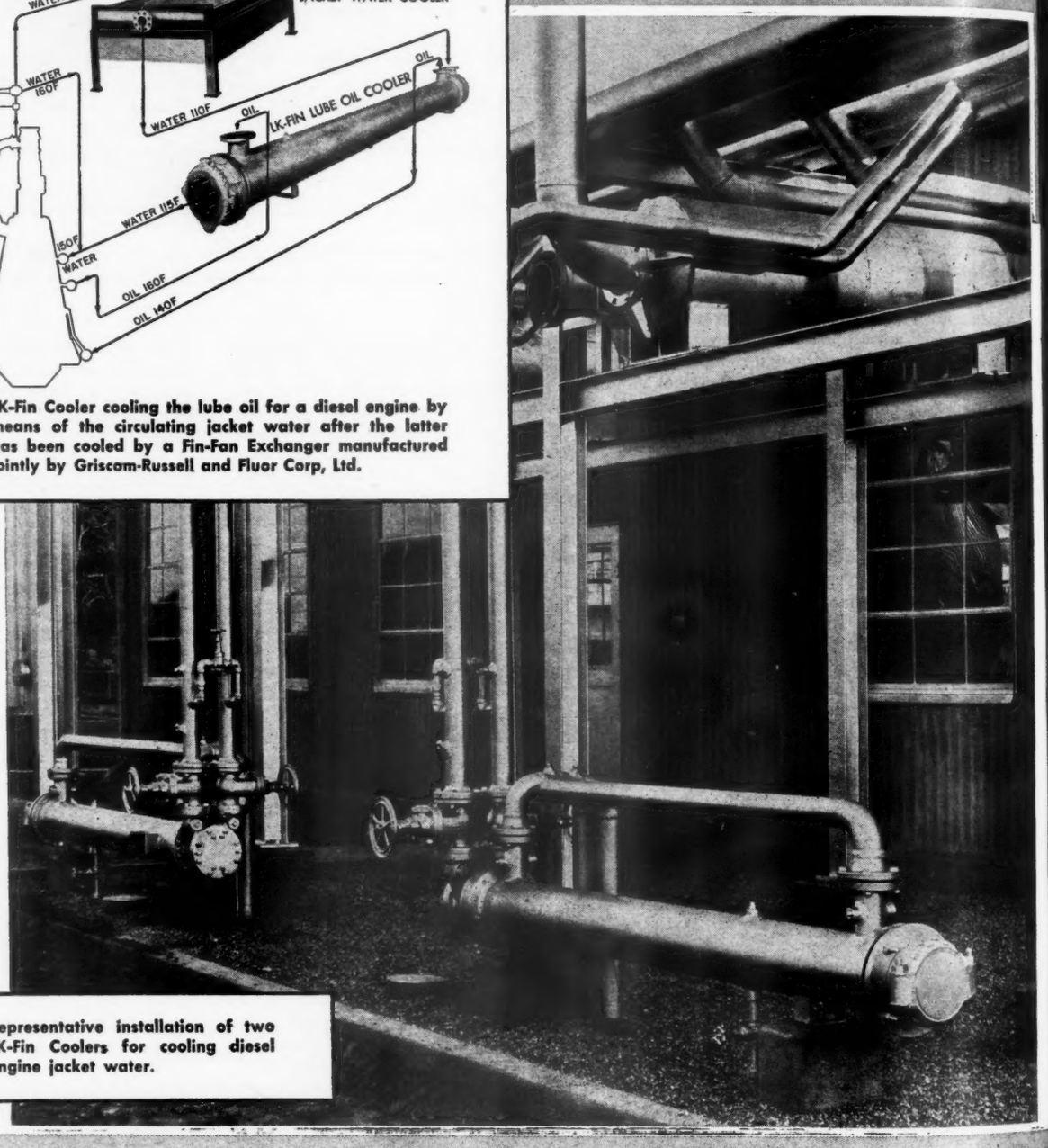

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The large areas of glacial drift may make gravity and magnetic work difficult to interpret, and the same drift and the weathered Tertiary and Upper Cretaceous shales make seismograph weathering corrections difficult to calculate.

Basement faults and normal faults on the edge of the old Williston Basin downwarp would not be surprising, but again they will be difficult to find.

The unconformity at the base of the Jurassic system and the pinchout of the Devonian and Mississippian sediments below present a good opportunity for pinchout trapping in the eastern half of the state. Those relationships provide one of the best possibilities for future oil discovery.

The many types of permeability variation in the rocks in North Dakota may afford any number of opportunities for traps, either alone or in places where complete structural closure is lacking.

The Silurian, Devonian, and Mississippian limestones and dolomites have several fragmental zones that may be expected to have distributions and facies relationships similar to those of other clastic rocks. Shoestring zones and updip pinchout of carbonate clastic may provide traps. Such traps, as well as many of the other types of stratigraphic anomalies will be found only on intensive drilling and after considerable subsurface sedimentological analysis.

The Silurian rocks pinch out, and the Devonian system pinches out or thins between the Bismarck area and the Cedar Creek anticline. No deep tests have been drilled in that part of the basin, but future drilling there has a good chance of finding production in the Silurian and Devonian on the southwest flank of the basin.

As we go to press Amerada has reported a second North Dakota discovery. It is the No. 1 Dilland, Williams County, 1½ miles north of original pool opener.

No reefs have been identified in the state, but they may be found in the Silurian and Devonian systems.

Good porosity has been noted in the Ordovician Stony Mountain limestones and in the Winnipeg sandstones. On suitable structures those formations are capable of producing oil.

Sandstones are present in the Amsden and Kibbey formations. The environment of deposition appears to have been favorable for oil generation, and oil may be found in those beds, either trapped as a result of the considerable facies changes, largely unknown to date, or on structure.

The Jurassic Sawtooth limestones have good porosity. Porosity and facies variations appear to be common, and, as stated earlier, rocks of similar lithology and age have produced gas and oil in Saskatchewan.

Rocks approximately correlative with the Muddy sand and the Dakota group of North Dakota have produced oil in Wyoming, and, although no significant shows have been reported in the state, production in North Dakota from those rocks is not impossible.

Zones of porosity are also present in the Greenhorn limestone and the Niobrara formation, in sandy beds in the Pierre shale, and in the Fox Hills formation. Possibilities of oil or gas production from those Upper Cretaceous rocks are not too encouraging, but they deserve mention as porous zones in a marine section.

Conclusion. In a region as inadequately explored as North Dakota, the realm of unknown geology is vastly greater than that of the known. Modern geophysical and drilling techniques make exploration possible and production profitable in this region where economics heretofore has discouraged exploration and development.

The brains, money, and luck of the wildcatter must be brought into full play, and imagination and courage must compensate for lack of knowledge. It should not be necessary to point out that every part of the section should be watched carefully during the drilling of exploratory wells and that every porous zone should be carefully checked and tested for shows of oil and gas. The use of mud-logging units should be encouraged.

The untested possibilities of the state are great; they should be and will be explored. * * *

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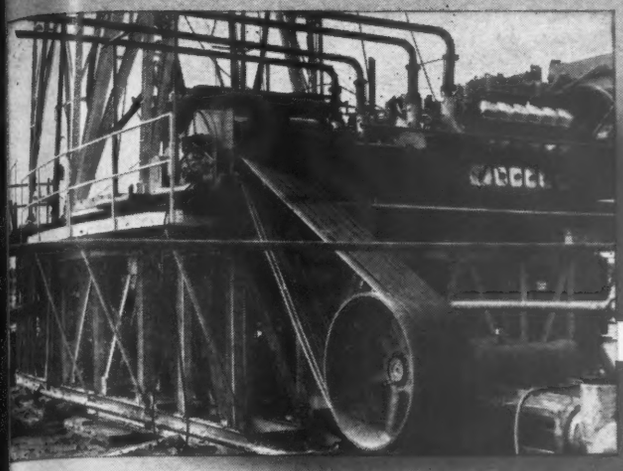

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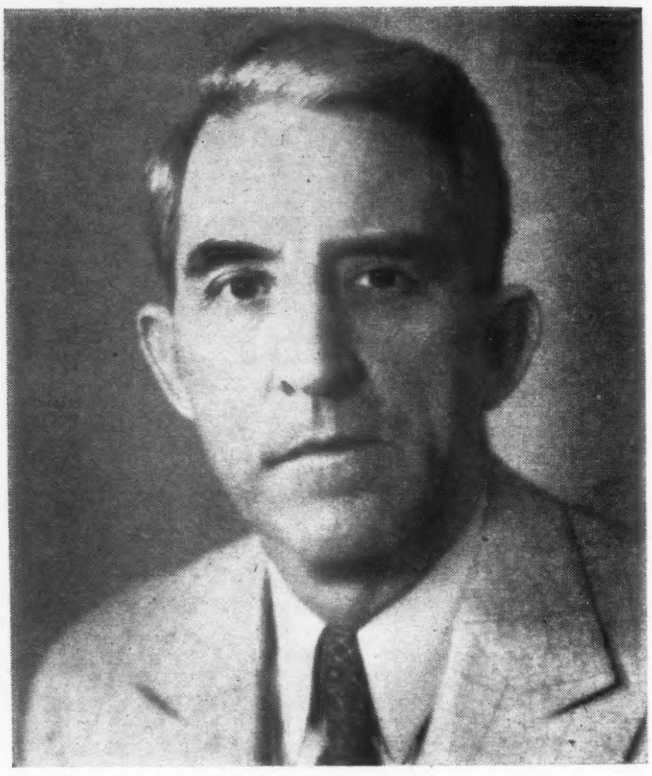
PETROLEUM PROFILE



WALLACE R. FINNEY
Pipe Line Advisor
Standard Oil Company (New Jersey)

WALLACE R. FINNEY, pipe line advisor to Standard Oil Company (New Jersey), has been associated with the oil industry in various capacities for about 37 years.

Born and reared on a ranch near Modesto, California, Finney was graduated from Stanford University in mechanical engineering in 1912. His oil field experience began in California with work in a pipe line gang.

In May, 1917, Finney moved from California to Oklahoma where he designed and built natural gasoline plants. The next year he joined the Midwest Refining Company, and after 11 years in Wyoming was transferred to New York in September, 1929, to supervise Lago's electrification program in Lake Maracaibo, Venezuela. He also assisted in gas plant and pipe line problems for the production division of Pan American Petroleum and Transport Company in Venezuela and Mexico. When the foreign properties of Pan American were acquired by Jersey Standard in May, 1932, Finney was transferred to Jersey's producing department to handle engineering work.

Finney became president and a director of Oklahoma Pipe Line Company, and vice president of Ajax Pipe Line Corporation in July, 1936, and moved to Tulsa where he also served in an advisory capacity to Standard Oil Company of Louisiana's pipe line department. In September, 1939, he returned to New York, again as a member of the producing department of Jersey to coordinate the operations of several domestic pipe line companies. He was made president of the Portland Pipe Line Company in May, 1941, and was in charge of the construction of the Portland-Montreal project. Likewise, he has been a director of Plantation Pipe Line Company since July, 1940, and conducted the entire planning of this refined products line.

In November, 1943, Finney was made vice president and director of the Mississippi River Fuel Corporation and the Interstate Natural Gas Company. In December he became president and director of Hope Producing Company and McKamie Gas Cleaning Company and director of Colorado Interstate Gas Company. At the same time the pipe line work was separated from the producing department and in January, 1944, the office of pipe line advisor was created. Finney was given the assignment and now serves in a consulting capacity to several natural gas, gasoline, and oil pipe line companies and acts as advisor to Jersey on pipe line matters in both foreign and domestic fields.

On December 12, 1944, the Interstate Oil Pipe Line Company was formed and acquired the properties of the Oklahoma Pipe Line Company and the Standard Oil Company of Louisiana's pipe line department. Finney served as president for the first year.

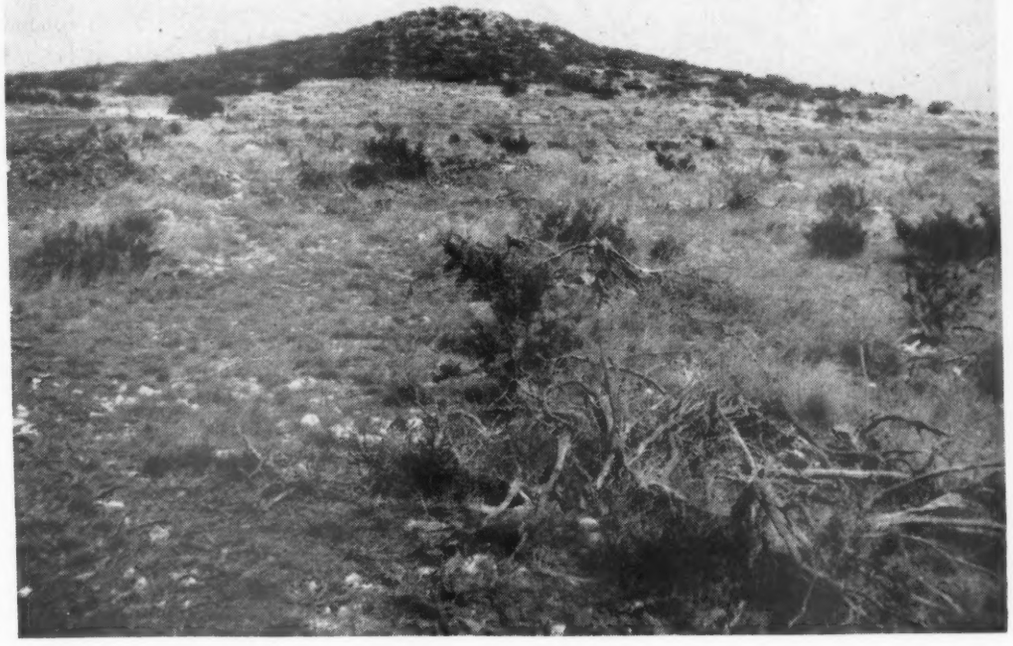
At present he is a vice president and director of Interstate Natural Gas Company, Inc., and Plantation Pipe Line Company and director of Interstate Oil Pipe Line Company. In January, 1948, he was named as an alternate director of the Middle East Pipelines, Ltd., assisting with the planning of the Middle East, Iraq, and Trans-Arabian pipe line projects.

During World War II Finney served as chairman of the temporary joint pipe line engineering committee that supervised design and construction of the "Big Inch" and "Little Inch" lines. He also served on several industry committees and as a consultant to other government agencies.

Since June, 1944, Finney has been a member of Jersey's coordination committee and acts as chairman of the subcommittee on pipe lines. He is also chairman of the subcommittee on tanker terminal facilities and in addition is chairman of the pipe line research and development advisory committee.

In October, 1950, Finney was appointed chairman of the subcommittee on pipe line transportation of the National Petroleum Council's committee on petroleum transportation and in March, 1951, he was asked to serve as a member of the National Petroleum Council's membership subcommittee on transportation of committee on capital and materials requirements (million barrel committee).

On eastern shelf of Midland Basin in Tom Green County, Texas, Plymouth and Benedum-Trees have discovered three oil sands in a closed structure



Susan Peak.

Development of the Susan Peak Field

D. W. GRAHAM

THE Susan Peak field, situated in southeastern Tom Green County, 20 miles southeast of San Angelo, Texas, was discovered in December 1948, when the Plymouth and Benedum-Trees 1-A Green was completed as a producer from the Lower Strawn limestone, sometimes called the Main Strawn limestone or Massive Strawn limestone. Although the Susan Peak field is on the eastern shelf of the Midland Basin, an area in which there are many Pennsylvanian reef oil fields, the occurrence of oil in the field is due to structural closure rather than reef building. This is shown by the fact that the Lower Strawn limestone thins 200 ft across the top of the field instead of thickening across the productive area as the limestone do in true reef fields. (See Fig. 2.)

The lease block on which the Susan Peak field is situated was originally taken jointly by the Plymouth Oil Company and the Benedum-Trees Oil Company on the basis of surface geological work. In 1947 the Plymouth Oil Company did seismograph work on this block and on the basis of the results of the seismograph work took a small additional amount of acreage on the north end of the original block. In the fall of 1948 the location for the Plymouth and Benedum-Trees 1-A Green was made on the basis of both surface geology and seismograph work. The discovery well was drilling at a depth of 4655 ft when a gas cap was encountered in the Upper Strawn limestone. This gas cap carried on down to a depth of 4700 ft, after which 24 ft of black shale was penetrated before oil was encountered in the top of the Lower Strawn limestone at 4724 ft.

A drillstem test of the top 20 ft of the Lower Strawn proved inconclusive, but samples strongly indicated a commercial producing zone. A string of 7-in. casing was run to a depth of 4708 ft and cemented. After the mud was swabbed off the pay section, the well was completed natural for a flowing potential of 362 bbl of oil per day on a ½-in. choke on December 16, 1948. Gas-oil ratio was 600 to 1 and the gravity

EXCLUSIVE

The Author

D. W. Graham, district geologist for Plymouth Oil Company for the West Texas district, received his B. S. degree in geology from A. & M. College of Texas in 1941 and his M. S. degree in geology from the same school in 1942. He joined the Navy in May 1942, and was released from active duty with the rank of lieutenant late in November 1945. He has been on the geological staff of the Plymouth Oil Company in Midland, Texas, since January 1946, and has been district geologist for that firm's West Texas district since April 1948. He was elected to membership in Tau Beta Pi, national honorary scholastic fraternity for engineers when the first chapter of this fraternity was organized at A. & M. College of Texas in 1949.

D. W. Graham

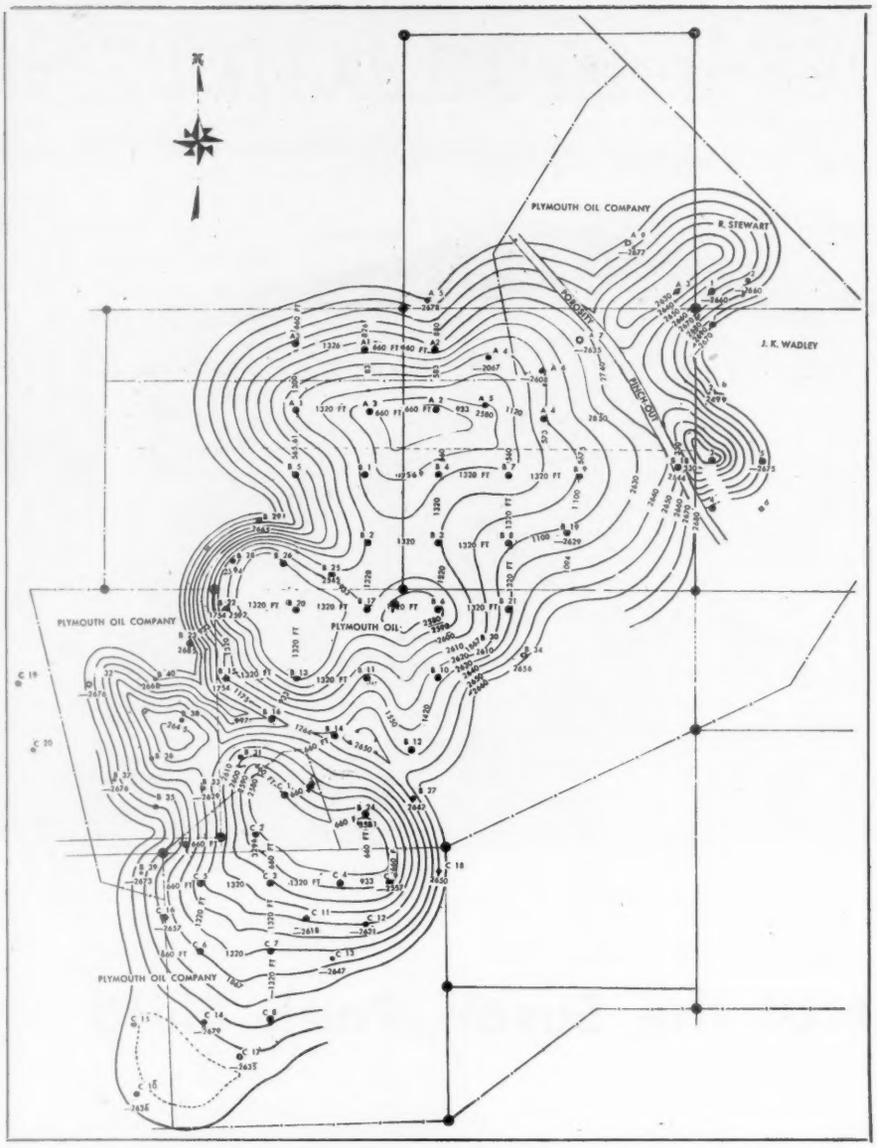


FIG. 1. Susan Peak field, showing top of Main Strawn limestone (contour interval—10 ft) and porosity pinch-out.

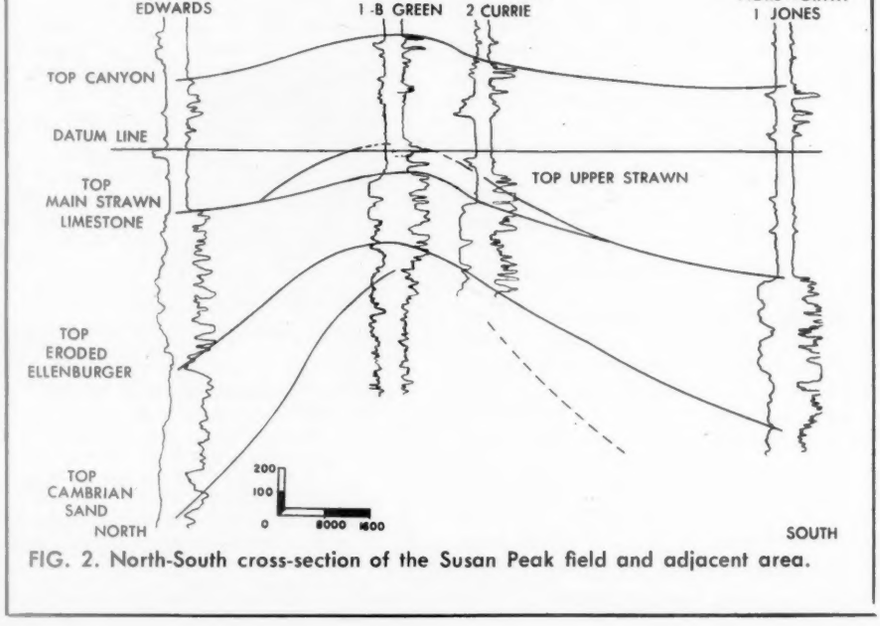


FIG. 2. North-South cross-section of the Susan Peak field and adjacent area.

of the oil was 37 deg. Soon after the completion of the discovery well, 3 rigs were moved into the area by the Plymouth Oil Company and development of the field proceeded rapidly for the following two years.

Drilling and production problems encountered in the development of the Susan Peak field were similar to those common to the Edwards Plateau area. Underground water is relatively scarce in this area and the productivity of the existing water-producing horizons is relatively low. After drilling a number of wells in an unsuccessful attempt to find an adequate supply of underground water, Plymouth finally came to rely on surface water from a creek several miles distant for its supply of water for the drilling of the wells.

In the first few wells drilled in the Susan Peak area, great difficulty was encountered in drilling the Cretaceous limestone, which lies on the surface in the Susan Peak field, forming a long, low, east-west striking line of hills, the central peak of which lies near the center of the field and gave the field its name. Large solution caverns in the Cretaceous limestone caused acute lost circulation problems. Many types of lost circulation materials, including mesquite bushes, cedar brush, cotton seed hulls, and chicken feathers were used in an attempt to fill the solution caverns and regain circulation. None of these materials were completely successful and cementing was finally found to be best method of regaining circulation.

The present method of drilling a surface hole is to cement the hole back to the surface when a large cavern is encountered, allow a few hours for the cement to set, and then drill out the cement and drill ahead. Sometimes several successive cementing jobs are necessary in order to penetrate the Cretaceous limestone, but in most instances this method has been found to be quite successful. This field is one of the few in the Edwards Plateau region in which cable tool rigs have not been used for the drilling of any of the surface holes.

In the earlier wells completed in the Susan Peak field the oil string was set on the top of the Lower Strawn limestone, and the wells were completed in the open hole below the casing seat. In the later wells this completion method was changed. Pipe was set through the pay and the wells were completed through casing perforations in the interest of better control of the producing conditions in the well. The perforated completion method has been particularly successful in controlling water encroachment in low wells completed close to the oil-water contact, but has been followed in all Lower Strawn completions regardless of structural position since 1949 because of the opportunity it affords the operator to change his completions to meet changing reservoir conditions.

In May 1949, Canyon production was discovered in the Susan Peak field at the Plymouth and Benedum-Trees 3-A Robertson. This well was completed for a

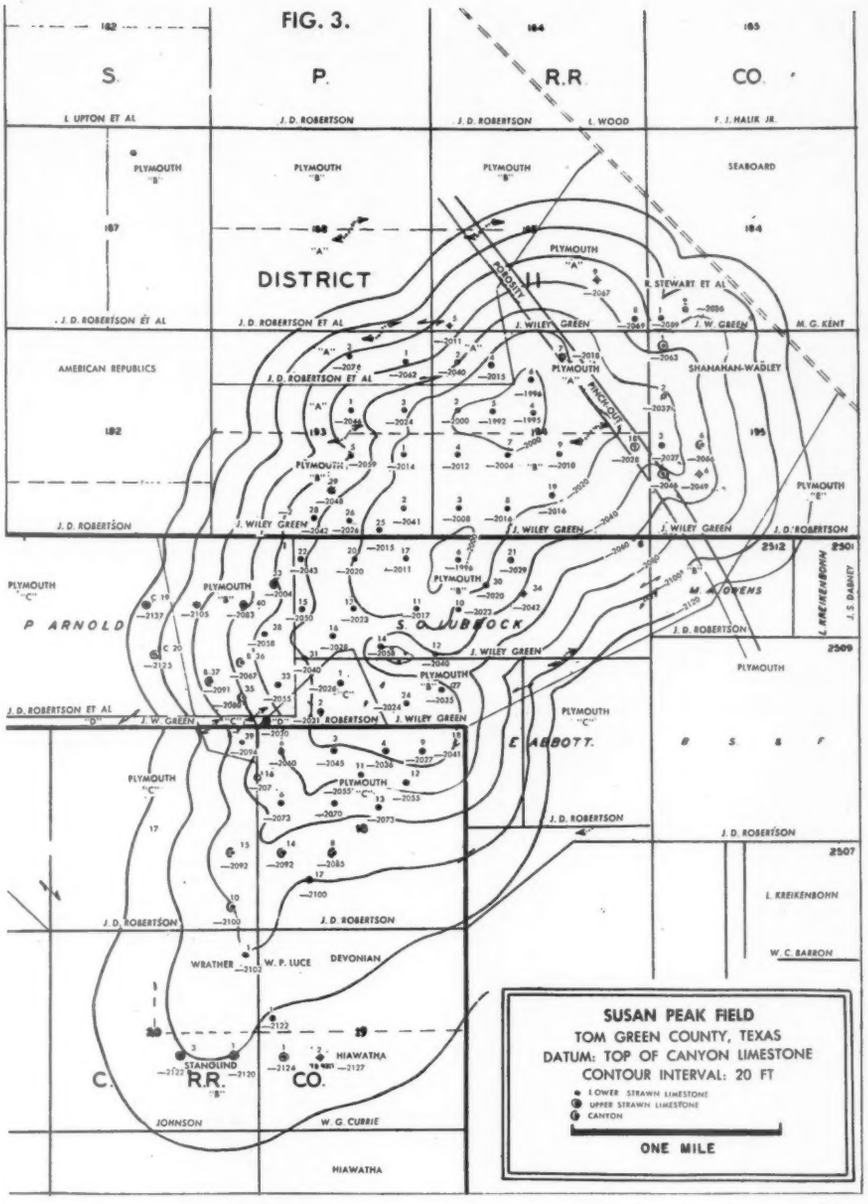
pumping potential of 67.7 bbl of oil per day from two horizons in the Canyon series from 4210 ft to 4240 ft and from 4360 ft to 4400 ft. In March, 1950, the first flowing Canyon producer was completed at the Plymouth and Benedum-Trees 1 Robertson-Green-State, which flowed 357 bbl of oil per day through a ¼-in. choke from perforations from 4485 ft to 4505 ft in the Canyon sand. In August, 1951, flowing production from the Upper Strawn limestone was discovered on the west flank of the Susan Peak field with the completion of the Plymouth and Benedum-Trees C-19 Robertson for a flowing potential of 120 bbl of oil in 24 hr on a 3/16-in. choke. Tubing pressure was 350 lb, the gravity of the oil was 39 API, and the gas-oil ratio was 530 to 1.

Of the three producing zones in the Susan Peak field the original producing zone in the Lower Strawn limestone is by far the most important and the most prolific. In this zone excellent porosity and an effective water drive combine to give a high reserve of recoverable oil.

In the Canyon series there are two productive horizons, the upper of which is a fairly low permeability limestone and the lower of which is a calcareous sand, which becomes a fairly pure sand in certain parts of the field. The Canyon limestone is a low pressure producing zone in which there is no effective water drive. In the area where the lower of the two productive zones in the Canyon series is a relatively pure sand, highly commercial flowing production is obtained from this zone. A water drive is known to exist in the Canyon sand, but the full effectiveness of this water drive is not yet known.

The third producing zone in the Susan Peak field, the Upper Strawn limestone, carries a gas cap across the entire area in which the other two zones produce oil. Only on the extreme south and west flanks of the field has this zone given

FIG. 3.



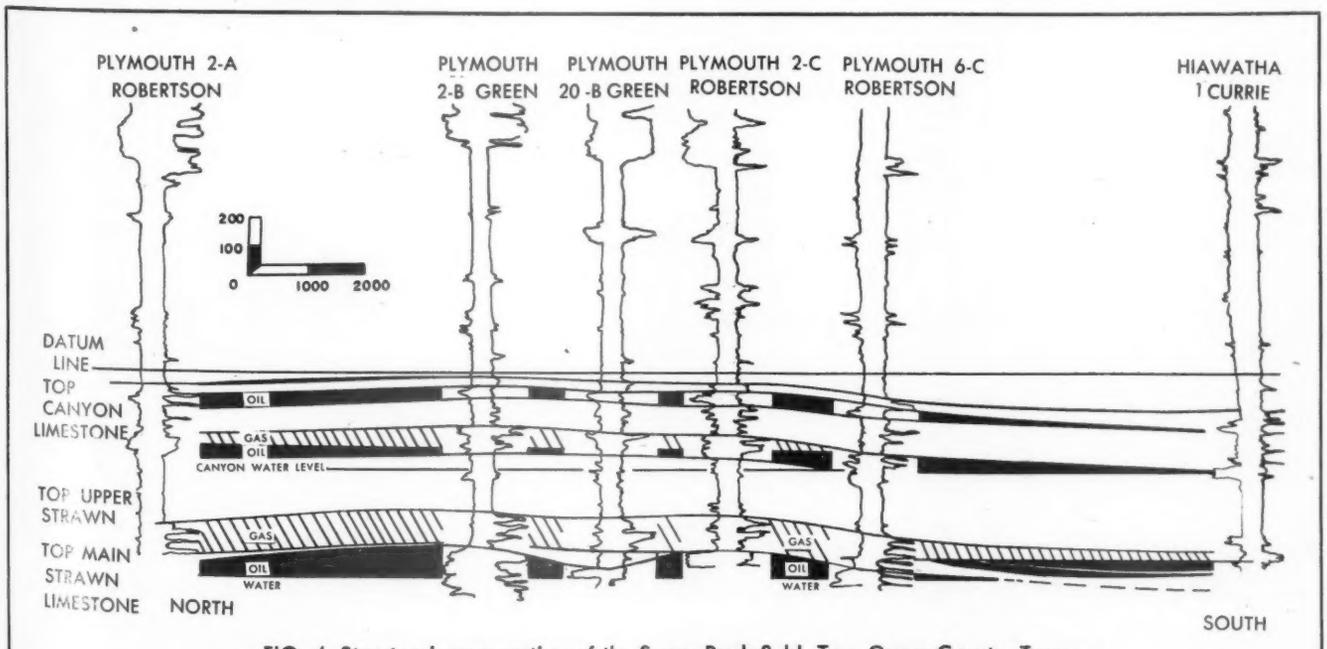


FIG. 4. Structural cross-section of the Susan Peak field, Tom Green County, Texas.

Left, typical rig Susan Peak field.

evidence of commercial production. There is no known water level in the Upper Strawn limestone, but drilling has not progressed far enough down the flanks of the structure to demonstrate conclusively the absence of such a water level.

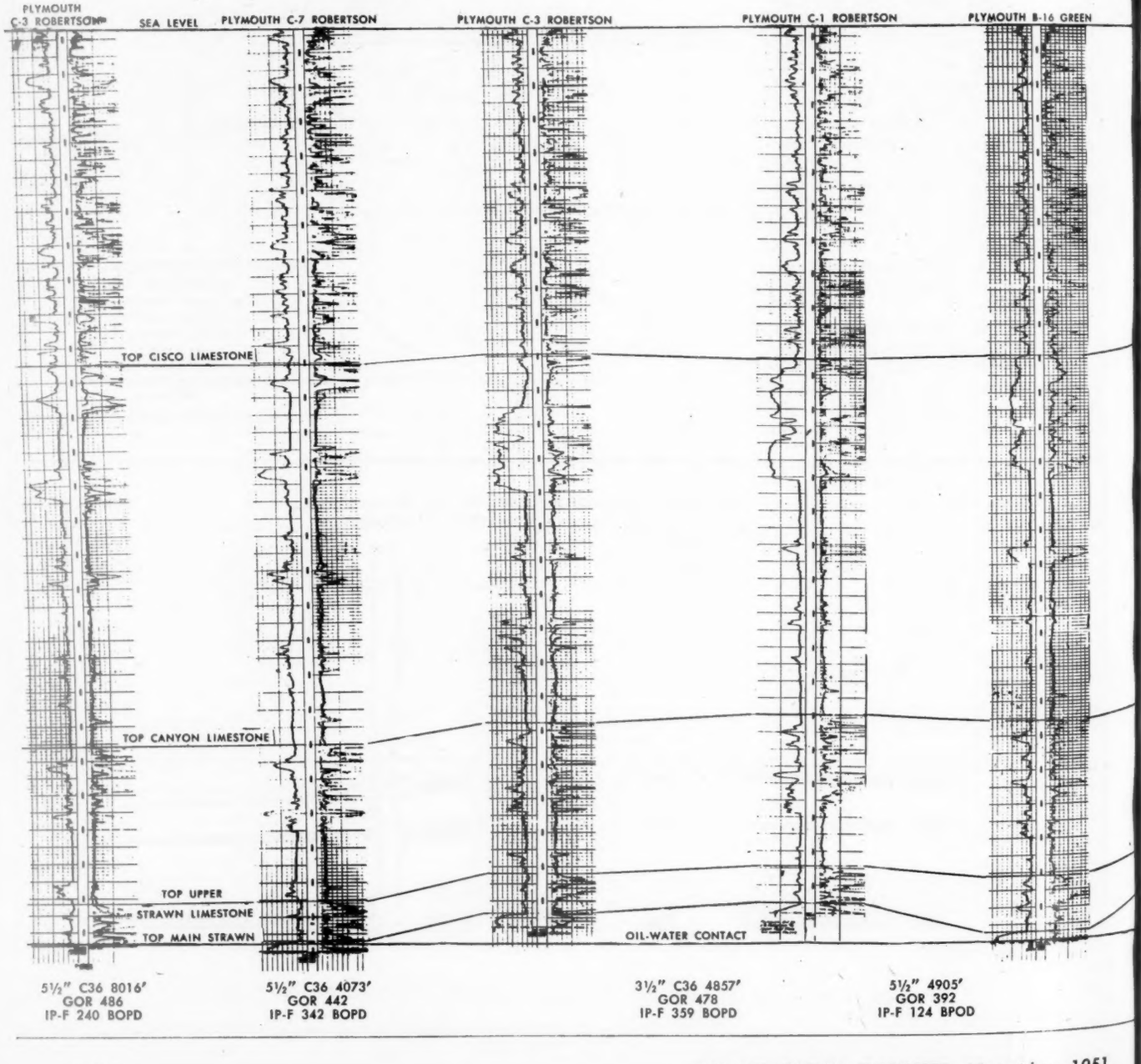
By September 1951, a total of 62 producing oil wells had been completed in the Susan Peak field, 47 in the Lower Strawn pay zone, 13 in the Canyon series, and 2 in the Upper Strawn limestone. In addition to these oil producers 4 shut-in gas wells in the Upper Strawn limestone and 3 dry holes have been drilled in the field.

This tabulation does not include the Hiawatha and Stanolind wells on the south end of the structure, which are completed in the Upper Strawn limestone and are recognized by the Railroad Commission of Texas as the South Susan Peak field, nor does it include Plymouth A-7 Green, Plymouth B-18 Green or any of the wells to the north and east of these two wells, as all of the above wells are separated from the Susan Peak reservoir by a porosity and permeability pinch-out. (See Fig. 1.) The presence of a porosity pinch-out separating this northeastern area from the Susan Peak field has been deduced from the following facts:

Plymouth A-7 Green and Plymouth B-18 Green were both too dense to produce from the Lower Strawn limestone even after repeated treatment with acid, although both of these wells were higher structurally than Plymouth B-16 Green, Plymouth C-13 Green, and Plymouth C-6 Green, all of which are producing from the Lower Strawn limestone.

The water level in the Lower Strawn

STRUCTURAL CROSS-SECTION OF SUSAN



limestone is 10 ft lower (—2680 ft) on the northeast side of the porosity pinch-out zone than it is on the southwest side of this zone (—2670 ft.)

There is a gas cap in the Lower Strawn limestone on the northeast side of the porosity pinch-out zone. The gas-oil contact is found at —2660 ft in the Plymouth A-8 Green. On the southwest side of the porosity pinch-out zone there is no gas cap in the Lower Strawn limestone although the top of this formation is encountered as much as 93 ft above the gas-oil contact in the Plymouth A-8 Green.

The gravity of the oil in the Lower Strawn limestone on the northeast side of the porosity pinch-out zone varies between 32 and 35 deg. The gravity of the oil in the Lower Strawn limestone on the southwest side of the porosity pinch-out varies between 37 and 40 deg.

The water level in the Canyon sand on the northeast side of the porosity pinch-out is found at —2265 ft. The water level in the Canyon sand on the southwest side of the porosity pinch-out is found 61 ft lower at —2326 ft.

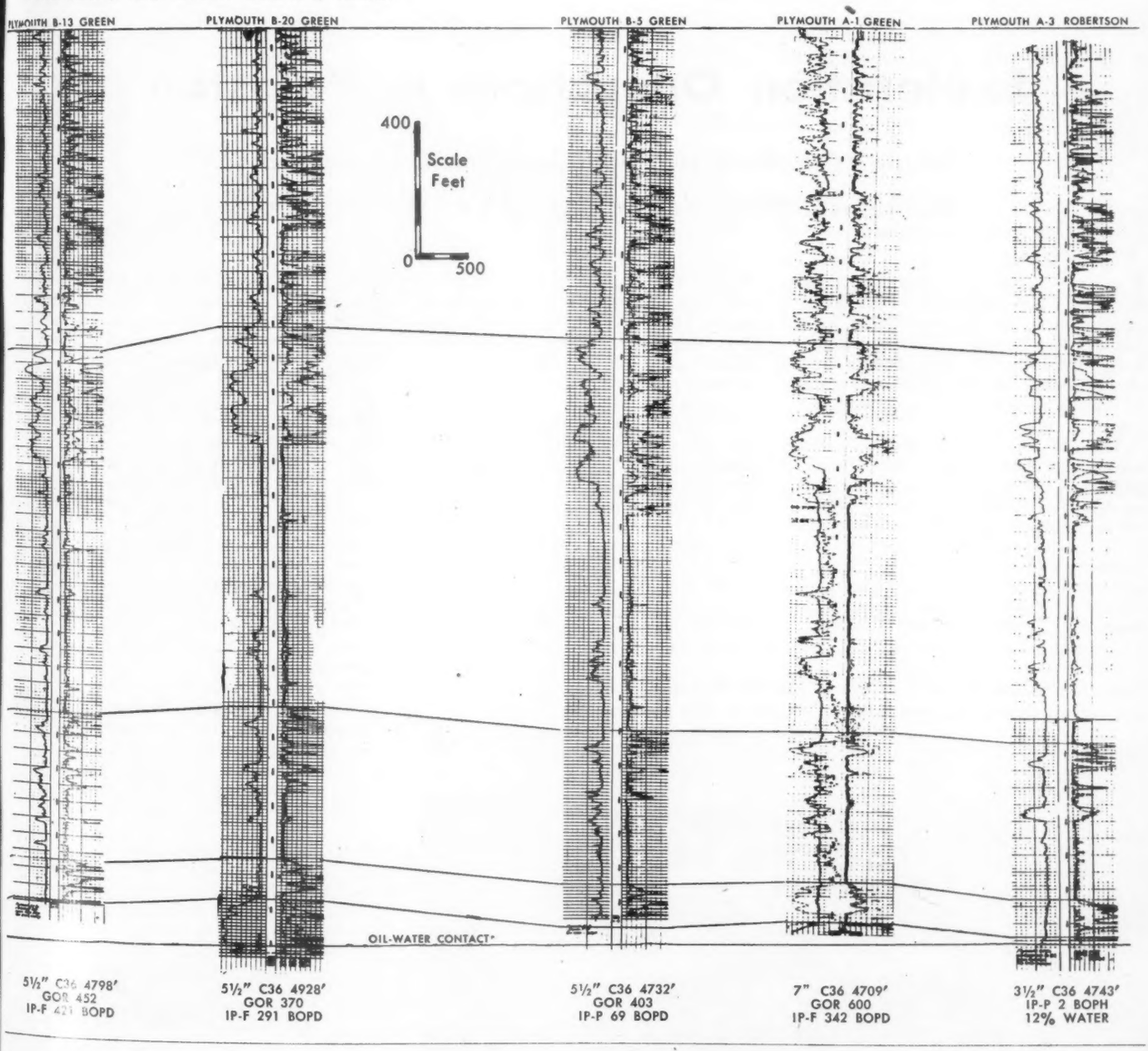
Regional geological correlations in this area are difficult to make because of the fact that this is a transitional zone between the typical West Central Texas geological section and the typical Midland Basin geological section. The Ellenburger is present in this area only in a highly eroded and re-worked state. Unconformably overlying the Ellenburger is the Lower Strawn limestone, which is believed to be equivalent in age to the Caddo limestone of the West Central Texas area. The Upper Strawn limestone is the approximate equivalent of the Capps limestone of the West Central Texas geological section. The Canyon sand of the Susan Peak field is believed to be of Middle Canyon age, while the Canyon limestone of Susan Peak is the equivalent of the Home Creek limestone of the West Central Texas region.

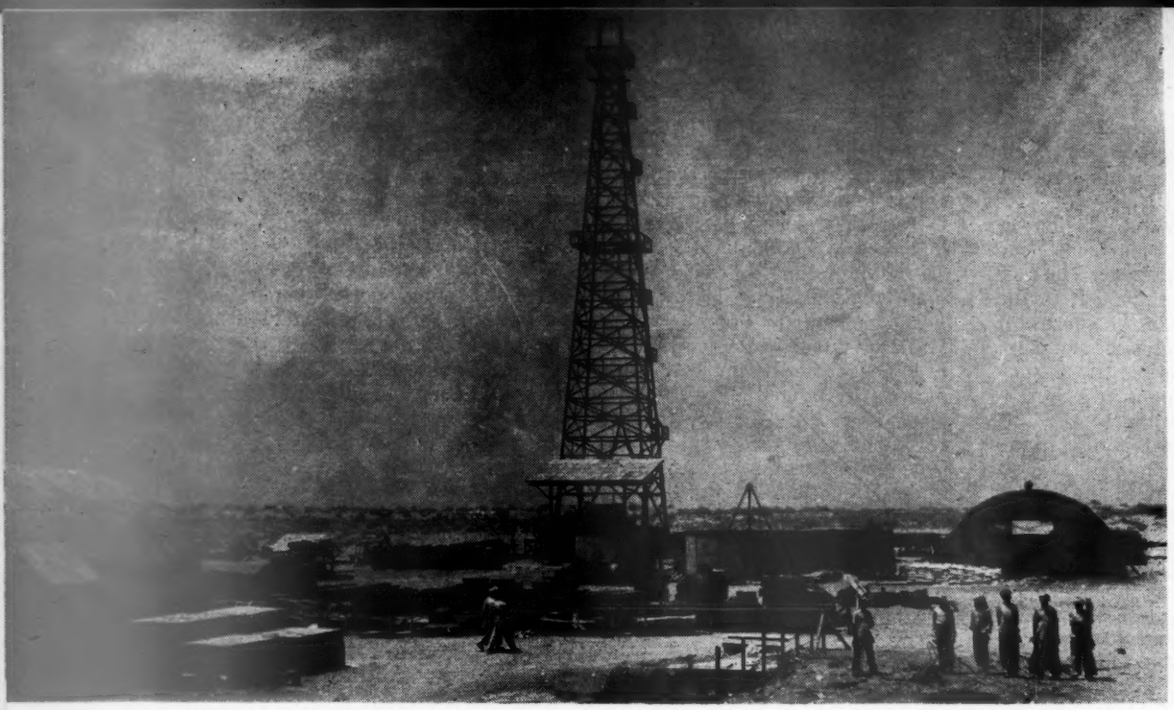
Plymouth and Benedum - Trees have now completed plans and have materials on order for the construction of a recycling plant capable of re-injecting 3,000,000 cu ft of gas per day measured at atmospheric temperature and pressure or approximately 300,000 cu ft per day at the estimated injection pressure of about 2100 lb. When this plant is completed and placed in operation it is expected to end all flaring of gas in the Susan Peak field.

At the present time the development of the Susan Peak field is essentially complete in the Canyon and in the Lower Strawn limestone. Development of the Upper Strawn limestone along the west flank of the field on strike with the Robertson C-19 and the Robertson C-20 is incomplete, and further development work will be done on this trend.

* * *

PEAK AREA, TOM GREEN COUNTY, TEXAS.





Pakistan Petroleum's test well at Sui rigging up.

Exploration Operations in Pakistan

Pakistan Petroleum, Ltd., with Government oil-prospecting license, is drilling the first test well on the Sui anticline

PAKISTAN PETROLEUM LIMITED spudded in its first test well at Sui, Dera Bugti (Baluchistan), in the morning of Wednesday, October 10. The test well is being drilled by the most modern type of diesel engined rig, which is capable of drilling to 10,000 ft if necessary, the company reported.

The site for this first test well was selected on the basis of geological work and aerial reconnaissance of about 5000 sq miles of Mari-Bugti territory, which led to the discovery of the Sui anticline.

Prospecting area is situated at the southern end of the Sulaiman range, and consists chiefly of narrow parallel ridges of closely packed hills, which form the gradual descent from the Sulaiman plateau into the plains. Though it is intersected by hill torrents and ravines it is, generally speaking, barren, rugged, and sandy, poorly supplied with water, and inhospitable. The climate ranges from 125 deg in the shade in summer to below freezing point in winter.

Preliminary work began early this year when the Government of Pakistan granted an oil prospecting license to Pakistan Petroleum Limited. To expedite work the company opened a railhead base at Kashmor on the narrow gage railway from Jacobabad to receive about 6500 tons of stores required for the project.

The test well site was a desolate spot with not even a foot track leading to it. A new 35-mile road winding its way through the plains, along the hill slopes, across the dry sandy bed of the Heran Nala and through the sand dunes was therefore constructed to connect the test well site with Kashmor railhead.

Simultaneously arrangements for water supply were taken in hand and a 40 mile 4-in. pipe line was laid with a pump station at the Indus river and a second intermediate booster station to pump water to the camp in the desert.

A camp for about 150 people was built. The houses are Nissen huts of special design with mud lagging to alleviate the great heat in summer and the cold in winter. A power station has been built to supply electric power for the well and light for the camp and for a hospital with air-conditioned ward for heat-stroke patients.

An air strip near the site has been constructed to enable landing of the company's plane and to ensure speedy movement of staff and urgent stores.

Communication is maintained by radio with Karachi headquarters, from where all the requirements are rushed to the site by rail, motor, or plane. Besides, a direct telephone line has been laid to connect the test well with the Kashmor railhead.

Also exploring in Pakistan are Standard Vacuum Oil Company (with aerial surveys) and Burmah Oil Company (with test well at Patharia). The Pakistan government announced oil exploration would be left in the hands of private enterprise.

* * *

View from fourble board of derrick at Pakistan Petroleum's wildcat showing warehouse and yard with part of camp in right background.

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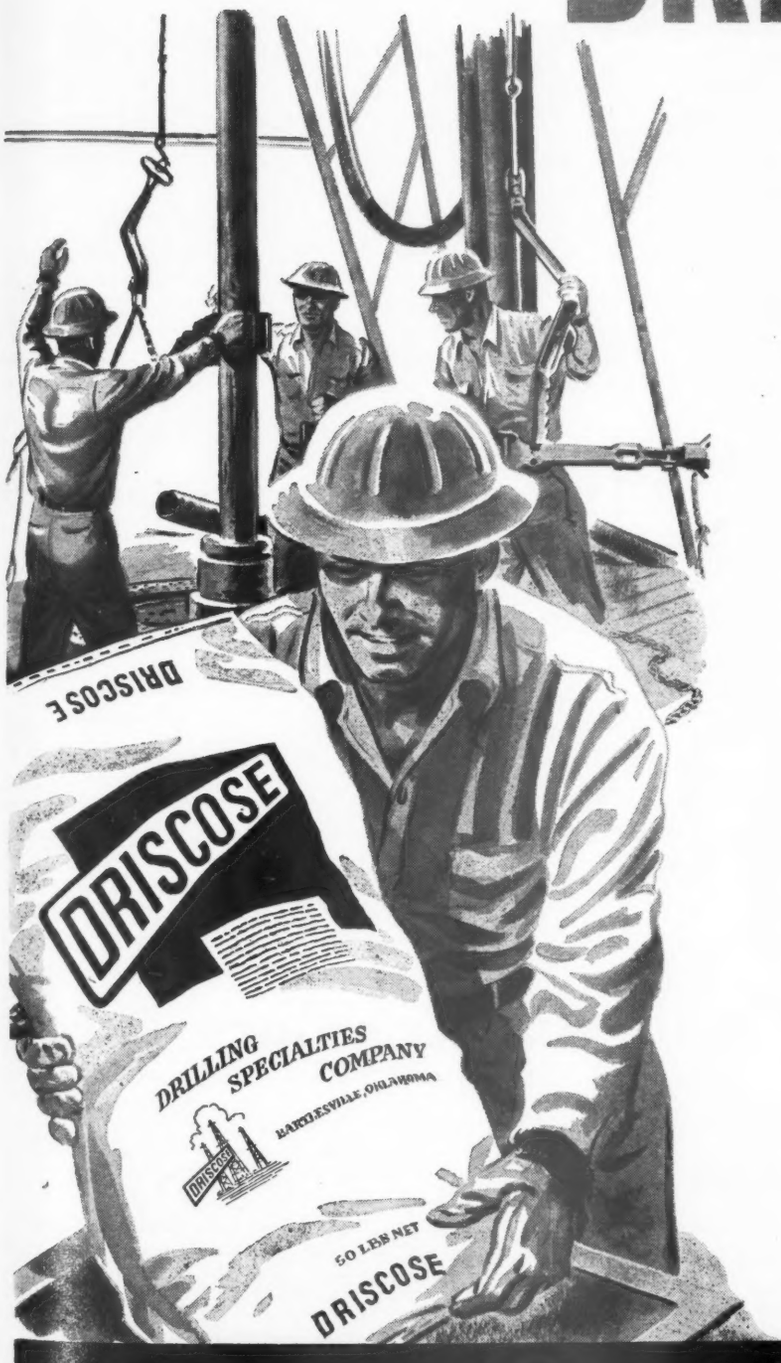

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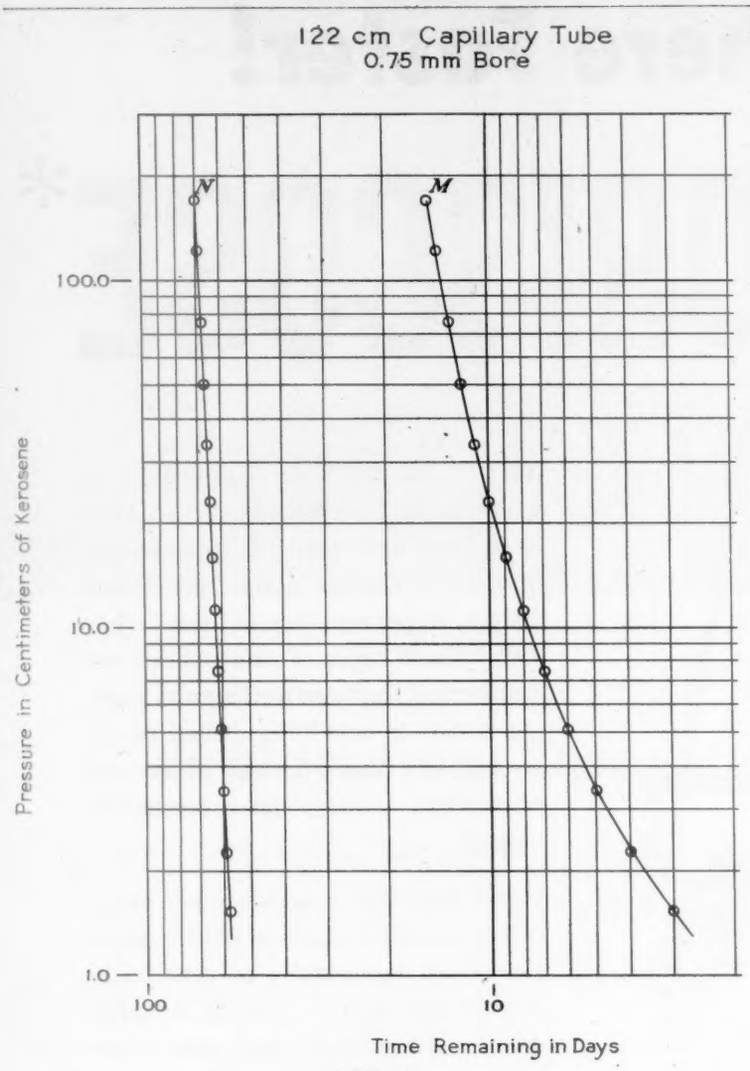

FIG. 1.

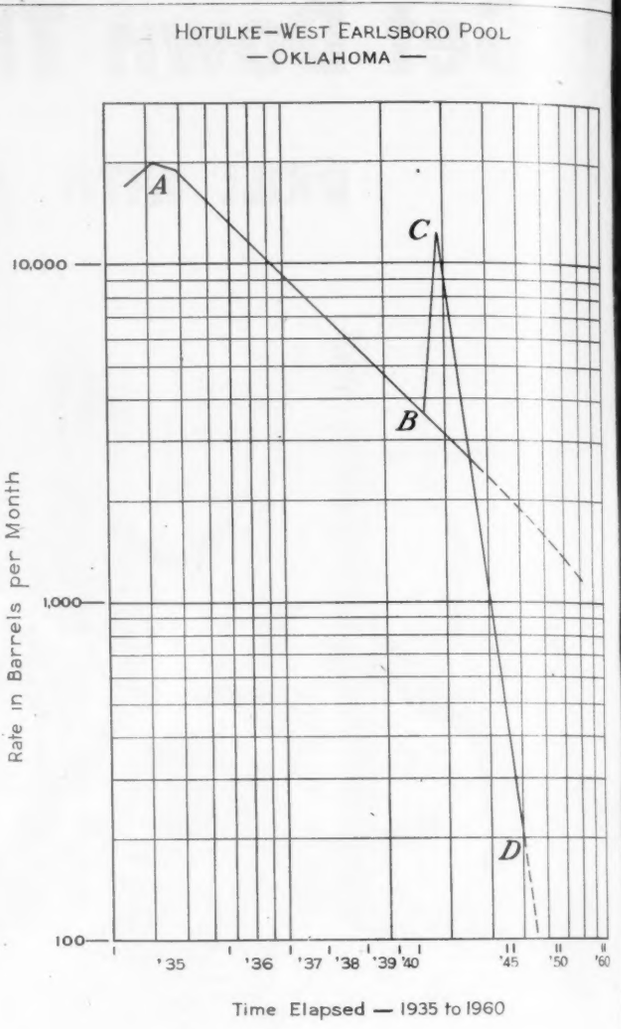

FIG. 2.

Data of Capillary and Non-Capillary Flow

STANLEY C. HEROLD

SOMETIMES in performing simple tests on flow we encounter unexpected and confusing results. Here is a brief account of one such experiment with what appear to be logical conclusions to be drawn from it. This test was performed with a 6 ft piece of 4-in. pipe mounted in a vertical position. The lower end had been closed by a metal plate welded in place. On the side, some 4 in. from the bottom, a 1-in. hole was drilled for the purpose of receiving a perforated rubber stopper. A glass stop-cock with a bore of ⅛-in. and capillary tube attached thereto completed the flow section of the apparatus. The tube extended outward horizontally, resting upon a bench.

The pipe served as a reservoir. For accurate measurement of the head of liquid contained therein a small float was suspended on a very flexible tungsten filament. This filament rode over a four-inch slotted wheel mounted with ball bearings at the top rim of the pipe, and supported a plumb bob which traveled at the side of an inverted steel tape mounted in position along the pipe.

Fig. 1 herewith pertains to the data of flow for kerosine through the capillary tube of 122 cm in length and of 0.75 mm bore. Observations covered twelve periods of flow, 24 hours each. During this test the head of liquid lowered from 167.13 to 1.52 cm as measured above the bore of the tube.

On the assumption that the head would reach zero at 15 days the successive readings described the curved line as it appears in the figure starting

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at M. Obviously the assumption was incorrect. It is necessary to shift all points toward the left, so that M reaches N, in order that the line may be straight. Now the line satisfies the condition of flow from the reservoir under the imposed conditions.

The remarkable circumstance, it seems, is the rapid change in the amount that the head lowers during the course of flow. During the first 24 hours the head dropped 54.93 cm and, in comparison, for the fifth period only 10.76 cm, while for the tenth period merely 1.70 cm. The final amounts were of course still less.

The slope of the straight line measures 30 to 1. Inasmuch as the slope of any straight line on a logarithmic plat represents the exponent in an equation denoting the relation between the functions pertaining thereto, in the present instance for the relation between pressure and time we may write

$$P = K\,T^{30} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

wherein

P = the pressure head in centimeters of kerosine,

K = a constant, and

T = time remaining for the completion of flow measured in days.

By calibration the pipe contained 82.8475 cm of kerosine per centimeter of its length. Obviously the content of the pipe as a reservoir at any instant varies directly as the fluid head. Without hesitancy we may then express the relation between the volume of liquid within the pipe and time as follows:

$$Vo = K\,T^{30} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Wherein

Vo = the volume of kerosine remaining to be produced.

K = another constant, and

T = time remaining, as before.

Now we are in a position where it is possible to write offhand an equation expressing the relation between the rate of change in the volume remaining at any instant of flow. This rate of change is in fact the rate of production at the instant. Whenever we are able to express the relation between a function and time by means of an equation, the first derivative of this relation with respect to time will correctly represent the rate of change in the function. Thus in the present instance we may write

$$Ve = K\,T^{29} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Wherein

Ve = the rate of production at any instant during flow,

K = still another constant, and

T = time remaining, once more as before.

Our constants are mutually related. Their values can be determined, should we desire them. But such values are not of significance except in respect to this particular apparatus with the units of measurement we have adopted. Here we are to consider general principles that do not require reckoning the values of constants in the equations.

By virtue of the fact that we have respective equations for the pressure and the rate of production, we may obtain their mutual relations by eliminating the function of time. To do this we simply take the 29/30 root of Equation (1). Thus

$$P^{29/30} = K\,T^{29} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Now Equations (3) and (4) have identical quantities on the right; consequently we can equate the quantities on the left:

$$Ve = K\,P^{29/30} \quad \ldots\ldots\ldots\ldots\ldots (5)$$

The rate of production from this particular reservoir with the capillary tube as described varies as the 29/30 root of the pressure head on the bore of the tube. This fraction is equal to 0.9667, almost unity, and having such a value it is significant. If in the laboratory we were to measure directly the relation between the rate and pressure, we surely would come to the conclusion that the rate varies directly as the pressure. The discrepancy between 0.9667 and 1.0000, would either be obscured by or accepted as experimental error. The advantage presented by our indirect method of determining the relation between these functions is clearly not one of attaining perfection, but rather one of obtaining greater accuracy with its clarity of analytical interpretation.

The French physicist, Jean Louis Marie Poiseuille, experimented with flow through capillary tubes some one hundred years ago. He found that within the limits of experimental error the rate of production, as above determined, varied in direct or straight-line relation to the applied pressure. As a consequence we have adopted such a variation in our computations respecting the performance of natural reservoirs producing oil and gas.

To proceed with our own experiment suppose we break the capillary tube in two, and repeat the test with a piece 60 centimeters in length. We would find the slope of the straight line to be thirteen to one on the logarithmic plat. The relation corresponding to Equation (5) would be

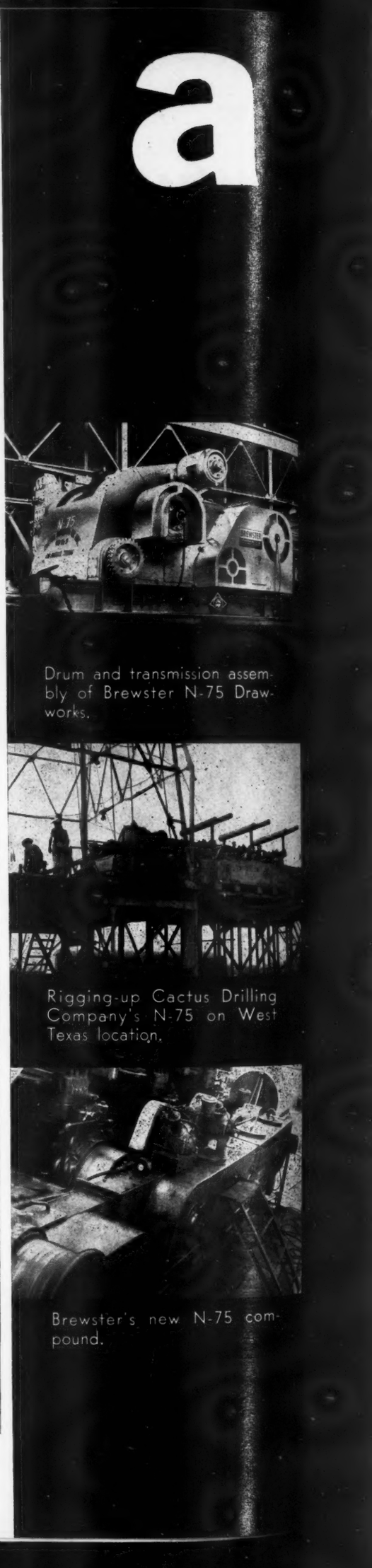
$$Ve = K\,P^{12/13} \quad \ldots\ldots\ldots\ldots\ldots (6)$$

This fraction is equal to 0.9231. There is a greater departure from unity; yet perhaps the value may be considered equivalent to unity within the limits of experimental error.

Now we should break the tube in two again and again, performing the test each time. In this way we would find an increasing departure from unity. Obviously the direct relation between the rate of production and pressure is becoming less tenable at each step. If we were to remove all restriction due to capillarity the relation between the functions would be

$$Ve = K\,P^{1/2} \quad \ldots\ldots\ldots\ldots\ldots (7)$$

To obtain the equation for flow free from capillarity we should preferably



Drum and transmission assembly of Brewster N-75 Draw-works.

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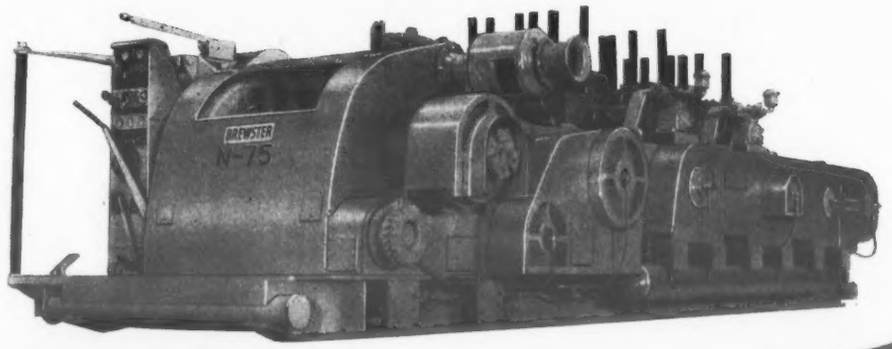

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perform our experiment with a kerosine can filled with water and provided with a nail-hole in the bottom. The finger will serve as a shut-off valve, and time will be measured conveniently in minutes. With this apparatus the orifice is of thin plate, as opposed to a capillary channel, and water is considerably less viscous than kerosine. Our line representing the relation between pressure and time will have a slope of two to one on the logarithmic plat, indicating the equation

$$P = K T^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

From this we can appropriately write

$$Vo = K T^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

and

$$Ve = K T \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

The latter is clearly the relation between the rate of production and time.

To continue as before we take the square root of Equation (8) to obtain.

$$P^{1/2} = K T \quad \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Now the right-hand quantities of Equations (10) and (11) are identical; therefore the left-hand quantities give us Equation (7).

The relation displayed in Equation (7) is that of Torricelli's Theorem. It is perhaps more easily recognized in the form of

$$v = \sqrt{2gh} \quad \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

In contrast to the earlier value of 0.9667 the exponent now has its lowest possible value of 0.5000.

Of particular interest to us is the intimate association of Equations (7) and (10). Where one faithfully represents the performance of a reservoir, the other also does so. Equation (10) specifies a straight line with a slope of one to one on the logarithmic plat.

In the Mid-Continent and Eastern fields the use of logarithmic coordinate paper is more common than elsewhere. Numerous examples of plotted data as they appear in the literature show the slope of one to one. Selecting one at random we may here refer to the record of the Hotulke-West Earlsboro pool of Oklahoma. This record is found in The Petroleum Engineer, issue of August 1950. The pool is definitely one that produces oil by virtue of an edgewater drive. Our Fig. 2 here is intended to be a faithful reproduction of the one in reference. There are, however, certain omissions and additions that accommodate the present discussion.

It will be noted that the data pertain to the rate of production and time, that the scales are logarithmic, and that the slope of the line is one to one between *A* and *B*. At least until the year 1941 the rate of production from the pool was not defined by capillary restriction. Had it been so restricted the slope would have been greater.

What can be said of the line from *C* to *D*? Shall we conclude that the performance of the reservoir underwent the influence of capillary restriction? According to the author we find that the line from *A* to *B* referred to the production of nine wells in the pool, and that these nine wells were all that were producing from the pool. They were confined to a specified "Area A." On the other hand, the line from *C* to *D* referred to subsequent production from 23 wells in the same "Area A." But during this time there were some 36 other wells producing from the pool on adjacent properties, and the records of these were not included in the construction of the plat. Had they been included, the line would have been parallel to that from *A* to *B*, and of course it would have had a higher position on the plat in order to accommodate the record of a greater number of barrels of oil produced per month.

In accordance with our study it appears that we can safely draw certain conclusions concerning the performance of natural reservoirs, namely: When in any case of plotting the combined rate of production of all wells in a pool against time we obtain a straight line with a slope of one to one on a logarithmic plat, we may be assured that flow within and from the pool is analytically free from capillary restriction. Under the circumstances described the Poiseuille relation is inappropriate, and the Torricelli relation is appropriate, as applied to computations respecting circumstances and events within the natural reservoir, regardless of whether or not the reservoir lies within a formation of granular texture. * * *

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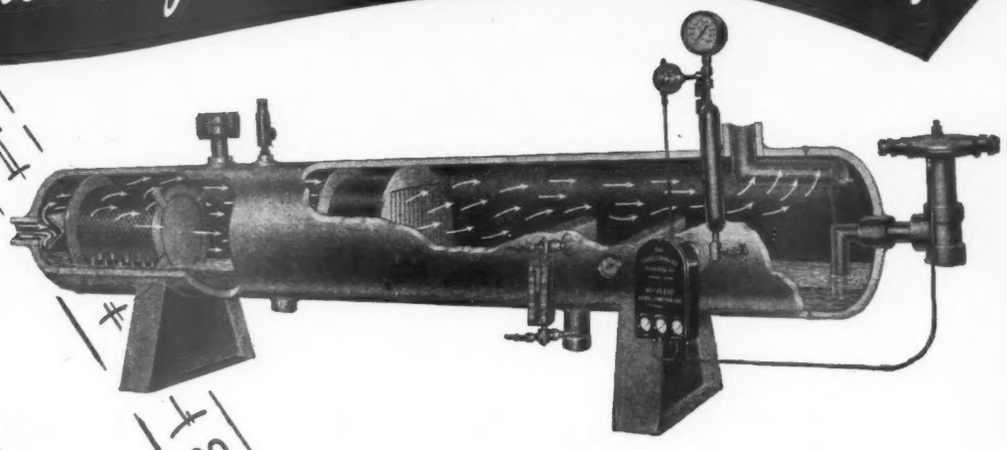

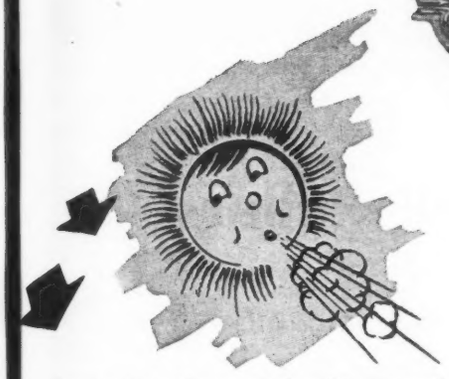

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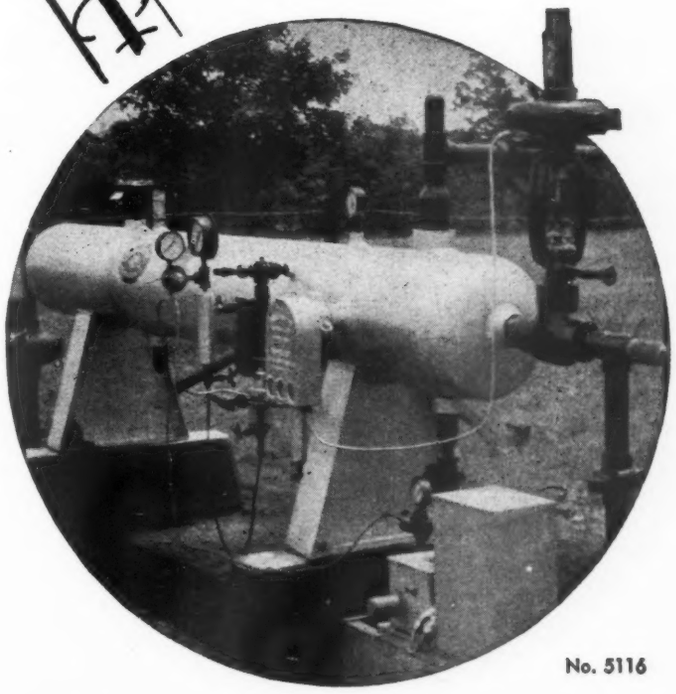

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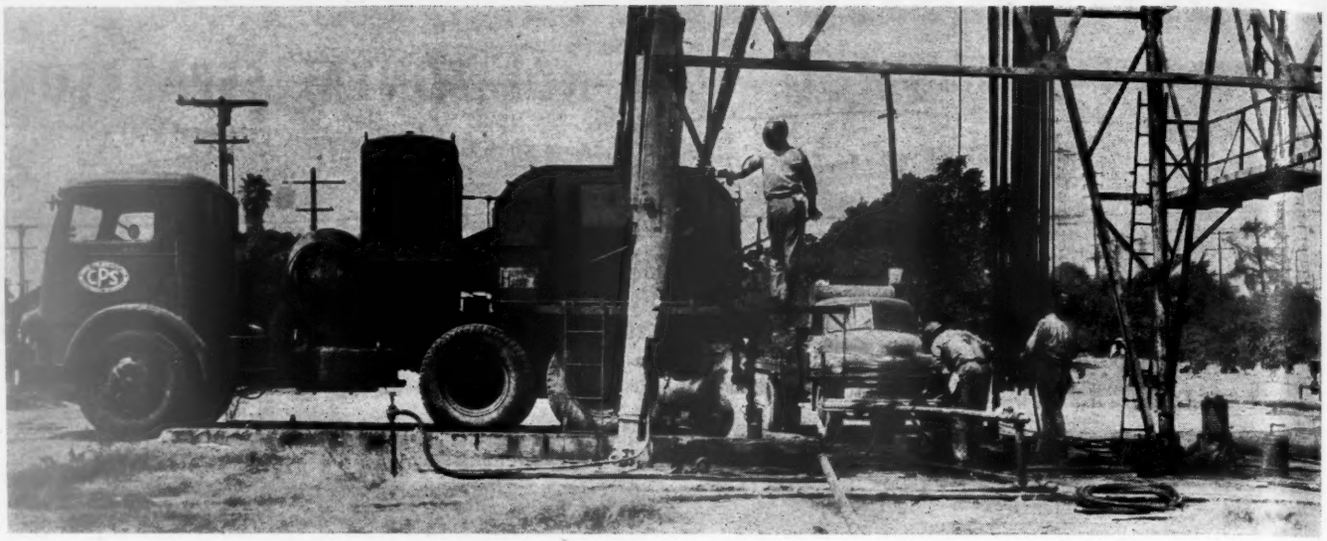


This is an example of good housekeeping. Everything not in use is out of the way. No litter, no muss, and note that the hoist operator is watching the progress of the blocks as he should be always when they are moving.

DO'S and DON'T'S for Well Pullers

Correct operation and safe operation are the same thing; oil fields and refineries are now safer than the average home.

RICHARD SNEDDON*

It is a long time since the petroleum industry stopped regarding safety as the exclusive business of safety experts and adopted the conclusion, with all its implications, that correct operation and safe operation are precisely the same thing. That is why in close cooperation with the workers themselves and with various specially informed individuals and organizations, the industry is gradually standardizing its every procedure, and in consequence making its oil fields and refineries with their high accident potential much safer than the average American home.

An interesting specific development along this line is the program of visual well-pulling education that is being conducted by California Production Service under the direction of Harry Hillman, president, and with the cooperation of the California Petroleum Safety Board. Utilizing an on-the-job sound motion picture that follows one of the company's own crews through every stage of a typical job, the whys and wherefores of each move are developed very effectively and very convincingly.

Beginning with a caravan consisting of a 90 ft telescoping rig on a 3-axle, low bed, semi-trailer, pulled by a heavy duty 3-axle, dual drive diesel tractor, and followed by a tool truck, the crews first make methodical and careful check of brakes, brake airlines, air pressure, fuel, oil, water, tire inflation, windshield wipers, fire extinguishers, and all lights. Assured that everything is in good shape for the road, engines are warmed up, windshields and rear view mirrors are cleaned, and the wheels are set in motion. Drivers of these heavy units are chosen as carefully as the units themselves, and observation of all road regulations and signs is an absolute must. It is the duty of the well puller to look over the road ahead, and any section that in his judgment is unsafe is simply not attempted. It is an unwritten law that in going up or down grades, the vehicle must start in the lowest gear that is likely to be required and stay there until the grade is negotiated. Shifting gears on a hill is an unforgiveable offense.

The mat for the rig is always laid on the lee side of the well so that oil and gas will blow away from it. When setting the rig down, the mat is first cleared and the well puller is aided by three members in spotting the rig in place—one at the well face to direct alignment, and one on either side to relay directions and see that all is clear laterally. On completion of the setting down process brakes are set and the engine killed.

The casing blow-down line must be pointed away from the rig to leeward, and should be at least 20 ft long with the control valve at the casing head. The derrick man's escape line, on the other hand, should be pointed *into the wind* and should form an angle of 45 deg with the ground. Important, too, is the location of the tool truck. Being normally the sole means of outside communication and transportation away from the rig, it should be placed where it can best perform its function and still remain undamaged in case of a blow out or other accident.

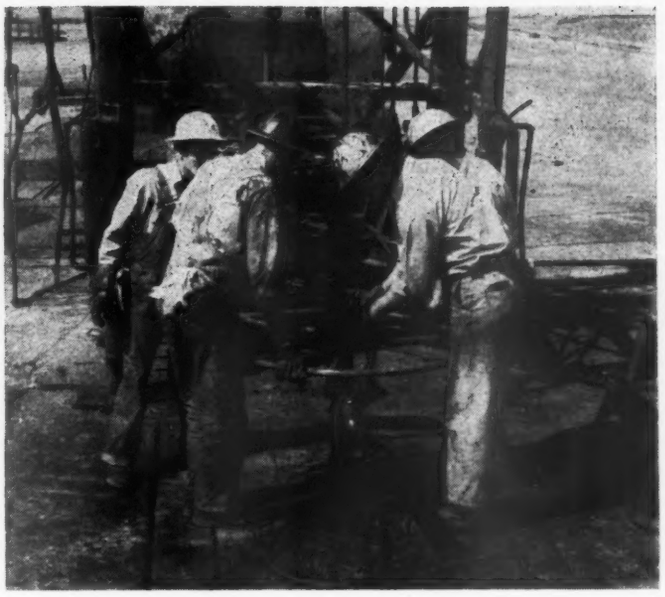
All members of the crew work together in properly levelling the rig after it has been set, and a large plate is used under each jack to provide an effective bearing area. (During this operation, locking bolts on the derrick are disconnected.) The levelling, of course, is necessary to assure correct line spooling and proper load distribution.

Before starting the hoist engine, water must be connected to the exhaust manifold. Air tongs are then unhooked from behind the tool truck and placed where they are not likely to be reached by blowing oil and gas. The tool truck, carrying such equipment as elevator links,

*Pacific Coast Editor.

EXCLUSIVE

Two members of the crew are seen breaking out a strand of macaroni. Coordination and team work are the secret of success in this operation. Deliberate, careful work is much better than speed as an accident preventer.



Operators are here using a rod safety wheel instead of a pair of wrenches to back off the rods. This shares the labor between all four crew men evenly. The use of a wrench on the periphery of the wheel is forbidden.

This shows position of the hands when hooking into the rod elevator. Points of contact between the two are the spots to avoid. Operators develop a smoothness and facility in performing such tasks that is more effective than speed, and much safer.

Setting slips around tubing. It will be observed that the operators stand with heads well back and hands well out on the handles of the slips. They show fine balance. The right man in steadying himself has his hand on a safe spot between the hook and the elevator.

elevators, spider and slips, crumbies, rod and tubing hooks, rod hangers, etc., is spotted where it will be in the least danger during erection of the mast. Crew members are required to wear goggles when repairing rope or chipping, and two pairs are always available in the tool truck. They must be returned to their proper place after use. A first aid kit is also a prime safety essential on each rig, and crew members are expected to report missing items so that they can be replaced at once.

Use of the proper tool for each specific job is mandatory, and it is equally mandatory that they be kept in good condition and always in the same place when not in use. The necessity for repair or renewal must be reported without delay, and the use of a 36 for an 18, or an 18 for a 36 is an invitation to accident that is regarded as poor practice. Similar care must be exercised with auxiliary tools and equipment such as chain tongs, pipe wrenches, star wrenches, polished rod clamps, jacks, wet boxes, etc. Excessive wear requires immediate repair or replacement to keep accident frequency at a minimum.

Fuel lines should be protected against damage, and vapor return lines should be connected during fueling operations. All fuel containers must have identifying marks on the outside to indicate the type of fuel content. It is distinctly dangerous practice to run the engine during the fueling operation, and allowing fuel tanks to overflow is introducing a hazard that is quite unnecessary. One thing that can apparently not be said often enough—never use gasoline or other low flashpoint liquids for cleaning.

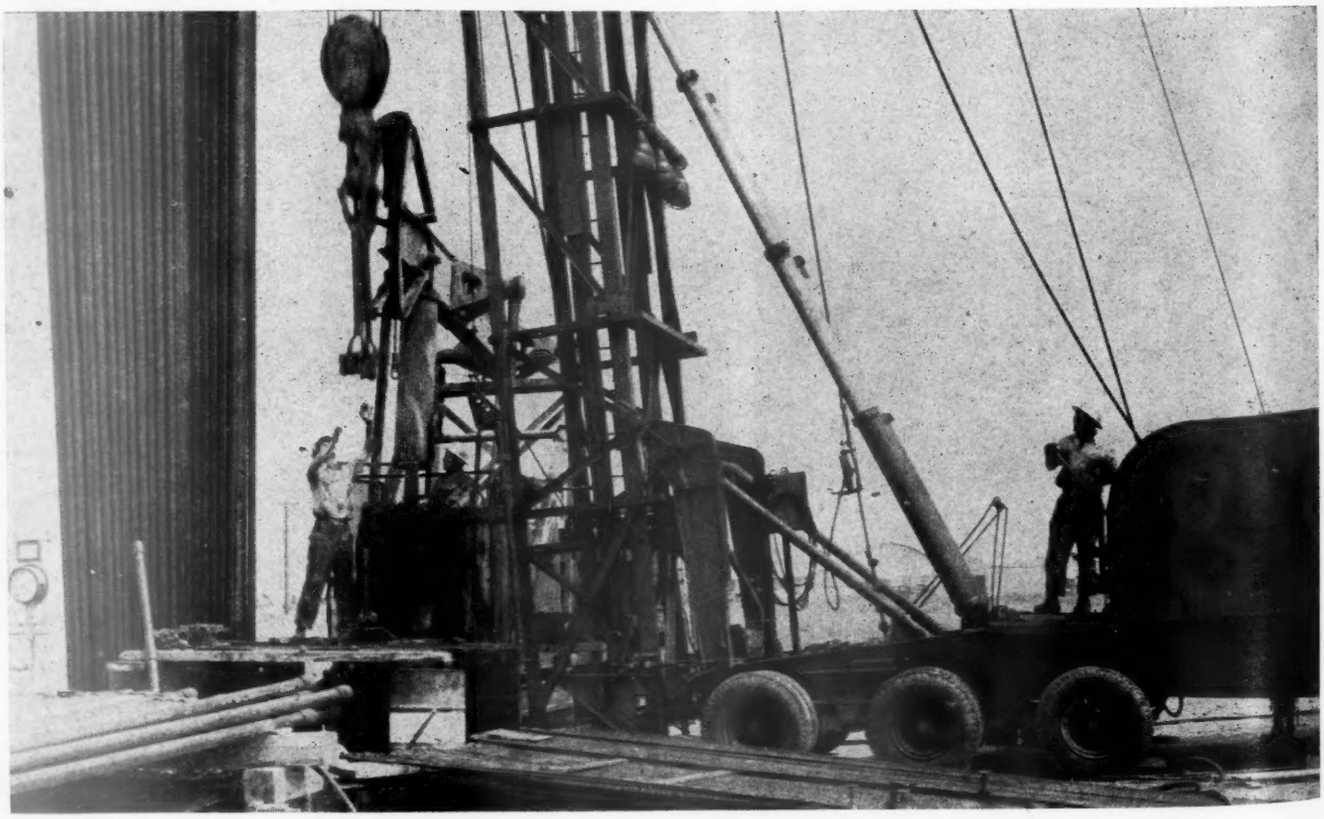
After the mast has been levelled, locking bolts have been removed, and the hydraulic system completely checked, the mast is started up. The head well puller handles the controls, and one crew member mans the sand reel brake, feeding the line off. The other two men are on either side of the rig watching that guy wires, rod hanger lines, etc., do not foul during the erection, and that the extended legs of the mast do not strike any of the well head connection.

When the mast is fully erected, the bolts locking it to the trailer are inserted and tightened, and the screw jacks in the base of the mast are run out and tightened evenly in the base plates. Levels are then checked to make sure that the mast is at proper pitch and is evenly balanced. Guy wires are next removed from the hooks on which they are carried and are stretched out in such a manner as to avoid fouling anything when the top section is extended.

For telescoping the top section of the mast, the head well puller is at the controls of the main drum, and one crew member is at the sand reel drum controls where he can feed off the sand line as the top section is raised. The other two crew members are on the lookout for fouling or hung up lines. Where a long stroke pumping unit is used, the racking platform is held up by the sandline until it clears the top of the unit. Thereafter it is lowered and locked in position, but normally the platform is lowered into position before the top section is extended. When lowering the mast after the pulling job has been completed, the same precautions must be observed. Guy wires are then stretched out as the mast goes down, and the platform is held up by slowly taking up the sand line. In this operation, too, it is necessary to check the loads on the trailer jacks; some may have changed position during the pulling job.

With the mast fully extended, all the locking bolts are inserted and made up tightly. The men on the ground should be clear of the wellhead while this is being done. The operation is best performed with two men in the derrick, and the head well puller and the other members of the crew stretching out guy wires and attaching the coffing hoists to the dead men. The coffing hoists are hooked into the special guy wire clamps after which the latter are made up tightly and evenly and the guy wires are snugged up to the hoist. The back guys are then uniformly tightened, and the same treatment is given to the front wires. Finally the platform stabilizing guys are installed, and the whole guying operation is examined meticulously. Uneven guying can reduce the rated capacity of the rig through distortion, so such a check is necessary, and, indeed, on a long term job, clamps, hoists, and guy wires should be inspected regularly to make sure that they are functioning properly. Screw pin anchor shackles must also be checked, and coffing hoists must be kept free of dirt particularly in the locking mechanism. In the latter case it is well to tie the handle.

Note in this picture that while the floorman is reaching for the descending elevators, the other two men are watching him intently. Independent action is hazardous, correlated effort is not.



Baash-Ross News

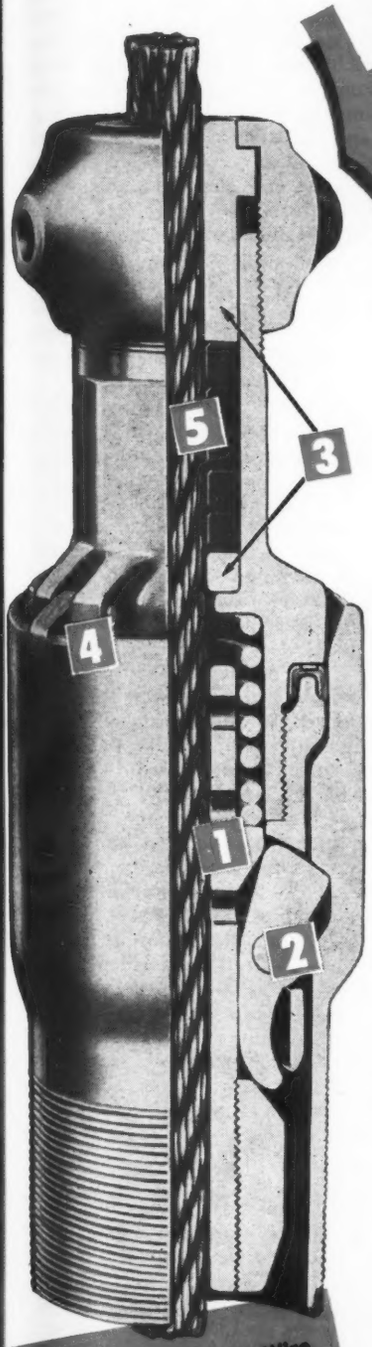
BAASH-ROSS TOOL COMPANY • LOS [illegible]GELES • HOUSTON • OKLAHOMA CITY • NEW YORK

OUR 32nd YEAR

LOOK INSIDE ...the BAASH-ROSS *Automatic* WIRE LINE WIPER

SEE THE UNIQUE FEATURES THAT MAKE IT FOOLPROOF AND COMPLETELY SAFE!

- **Releases and Resets Entirely Automatically!**
- **Instant Release Prevents Line Strain!**
- **Bronze Bushings Prevent Steel-to-Steel Sparking!**
- **Locks Automatically Against Rotation!**
- **Segmented Packing Assembly Wipes Cleaner — Simplifies Maintenance!**



You can get Baash-Ross Wire Line Wipers to fit any size from 3" line pipe to 9" casing...and with interchangeable rubbers and bronze bushings for all line sizes from ⅛" through ⅞". There's a size to fit practically every wire line operation on all types of rigs.

Here's an automatic Wire Line Wiper you can depend on for keeping oil and mud from slicking up your rig floors, jeopardizing the safety and efficiency of your crews during wire line operations. Simply connect the body of the Wiper to tubing head, gate valve, Christmas Tree or drill pipe and place the pack-off assembly on the line. Then as the line is pulled out of the hole, the packing assembly wipes it clean and dry...and *automatically releases* from the body when contacted by the rope socket. No necessity for flagging the line...no need to slow down operations as tool approaches the surface. This means *faster* operations, *safer* working conditions, *higher* crew efficiency.

BUT THERE'S MORE TO THIS WIRE LINE WIPER THAN JUST A PACKING UNIT AND A BODY—*TAKE A LOOK INSIDE...*

1 Note the unique design of the operating mechanism. As the tools are lowered into the hole, the pack-off assembly *automatically* latches into proper sealed-off position in the body. Then as the tools are withdrawn, all oil and mud is wiped off the line and confined to flow lines. Even possible gas leakage is sealed off by a special packing ring between the body and packing assembly.

2 Note the simplicity and direct action of the release mechanism. The instant it is contacted by the rope socket *it releases.* There are no complicated mechanisms, no delay or inertia to strain a fast-moving line while release is effected. *The Baash-Ross Wiper releases instantly!*

3 Note the bronze inserts *both above and below* the packing rubbers that prevent the steel line from contacting the steel wiper body. No chance here of steel-to-steel sparks touching off gas or oil conditions...a vitally important safety feature!

4 Another feature that's mighty important—there's a foolproof latch that *automatically* locks the pack-off assembly against rotating in the body as the spiral lay of the line is pulled through the Wiper. This keeps the pack-off unit from spinning, reduces wear, increases safety and insures cleaner wiping.

5 And take a particularly close look at the packing unit. It's not just a solid block of rubber, but consists of *many* tough, rubber segments working together and so designed that they provide a *series* of wiping edges against the wire line—not just one edge. This means cleaner wiping.

It also makes possible other advantages. By means of the threaded cap the packing element can be quickly tightened to take up any wear that occurs—insuring longer wiping efficiency...and any portions that show excessive wear can be quickly replaced without changing the entire packing unit—an important economy feature!

Baash-Ross Wire Line Wipers are another of the many Baash-Ross products **AVAILABLE THROUGH LEADING SUPPLY STORES** Contact yours for full details!

On wells equipped with skid-mounted units, movement of the equipment must be slow and smooth as it tends to be top heavy. All locking bolts must be removed before skidding is attempted. When ready to start the pulling job, the derrick man is required to ascend the ladder deliberately and carefully, and as soon as he reaches the platform puts on his safety belt, making sure that the rope is short and secure. It is *his* safety belt and he must make sure that the latch closes easily and completely with sufficient spring pressure, and that the ends of the rope are safely tied or spliced.

In the actual pulling job, team work is of prime importance. Each man must co-ordinate his effort with those of the other three, the floor must be free from non-essential equipment, and all potential known hazards must be eliminated. Knocker type wrenches are preferred by this organization, but the main thing is to have them in good condition and to use the right size for the job in prospect. Worn wrenches are dangerous. Rod elevators must also be checked for size to make sure that ¾ in. rods are not pulled with 1-in. elevators. Wear points are the latch itself and that particular area where the upset of the rod seats. When this latter area wears unduly, it tips, and a worn latch might easily let the rods slip out. Latch springs must be strong, the dogs, if worn, must be built up, and seats must be kept true to guard the men on the floor from the menace of falling rods.

The rod hook is always gripped at the latch release midway between the danger points of latch and bail. Elevators are operated with the hands about half way up the bail away from the hook and the rod seat. When unscrewing or screwing on to the rods, a safety rod wheel is used and wrenches are never applied to the outside of it. As the elevator reaches the derrick man, he should immediately attach the rod-hanger grip allowing the rod to spin freely in it as the sand is broken out. As the block drops, the load is caught on the grip and the elevators released. The hook and block are pushed away from the finger and the stand guided towards the hanger. The derrick man must avoid slam-bang operation to eliminate the possibility of broken chains and the jumping of the stand out of the grips; and he is required to inspect rod hanger and clamps at frequent intervals.

Worn or cracked grips pose the threat of dropped rods and injured crew men. They must be under constant examination. Grips should be kept clean to prevent slipping, as this may cause bouncing to such an extent that the rod may bounce right out of the grips and fall to the floor. Hangers must also be shop inspected at regular intervals.

In a good team, the men during a pulling job dovetail their efforts very neatly. Each remains pretty much in the same spot throughout the operation, and the work proceeds fast and smoothly. Wrenching rods is an art, perfection in which comes with practice if the basic requirements are observed. The operator pulls the wrenches toward him, thus preventing them from slipping off, and so at the same time avoiding the discomfort and embarrassment of a broken finger. It is an actual fact that oil men are so safety conscious that when they do become involved in accidents they are usually more embarrassed than hurt, even when they are hurt quite badly.

The team action, which is safety personified, is as follows: One man grabs the hook and releases the latch; the other removes the empty elevator as the first one puts the bail of the loaded elevator into the hook. The head well puller engages the clutch, and after the elevator bail automatically closes the hook latch, up go the rods. He watches the block as he does always when it is traveling, never takes anything for granted, and never allows himself to guess what the other men are doing. He finds out by actual observation.

Singling or doubling down rods is sometimes necessary, in which case the head well puller controls the speed of the blocks so that the man tailing the rods doesn't have to hasten his work unduly to keep up with the operation. Meantime, the walk way must be kept clear of all objects that might cause a stumble, and rods are laid carefully on boards. When tailing in, rods are handed to the man on the floor and not allowed to swing in. This should also be procedure when handling tubing.

If you want extra long, extra productive service life from the oil field equipment you build or buy, make sure Aetna Bearings are on the job. Aetna Bearings are products of the most modern facilities : . . and of technical skill unsurpassed in the industry. They are especially engineered to meet the high load capacity, high reserve stamina and 'round-the-clock dependability required in the most rugged oil field applications. Write for complete information . . . TODAY!

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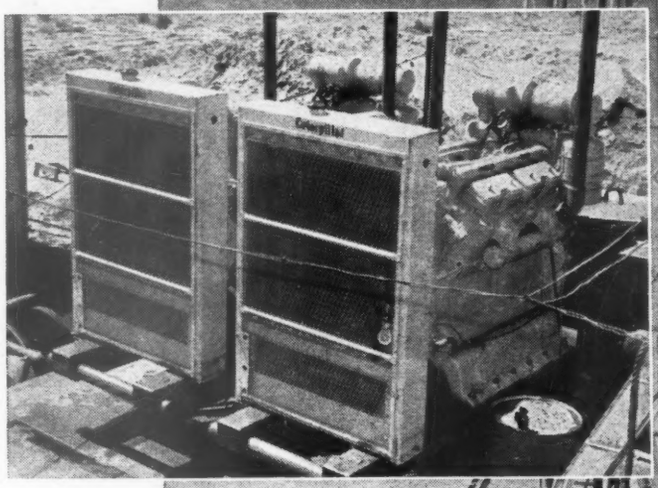
A couple of new hands make good!

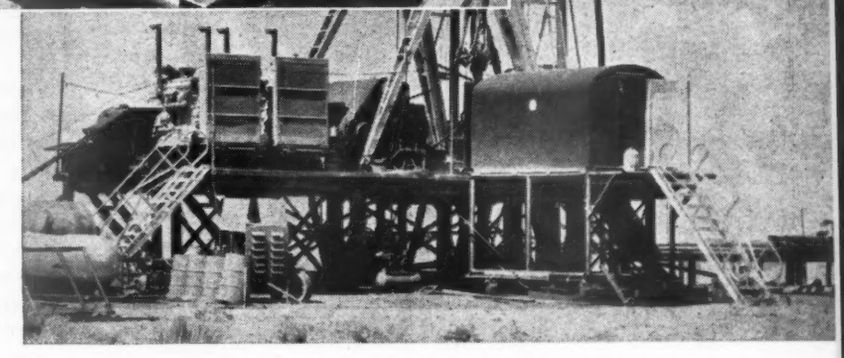
Typical of the reports coming in about "Caterpillar's" big new Oilfield Engines is this one from W. B. Barnett, driller for the Western Drilling Co., Lubbock, Texas. He says: "For twenty-four-hour service, efficiency and ease of operation, the two D375 'Cat' Oilfield Engines we have are the best I have operated."

These two D375s are compounded to drive the Oil Well mud pump and Emsco drawworks on this 8,500-foot rig in operation at Whiteface, Texas. When this picture was taken, the hole was down to 4,400 feet, with 600 to go. Time-table for the setup: rig up, 10 days; drill, 13; complete, 16; tear down, 1.



"Cat" Oilfield Engines, in 10 sizes up to 500 HP., are designed for rugged oilfield duty. They're compact, yet they deliver plenty of power—their rating is honest. They're tough, built to stand up under the roughest rig service. And they're dependable, engineered to stay in there pitching with a minimum of down-time. For your electrical needs, "Caterpillar" Diesel Electric Sets are built in 10 sizes up to 314 KW.

There's another big plus for you when you use "Caterpillar" power. That's the on-the-job service from your "Caterpillar" dealer, on call day and night. His servicemen are skilled and his up-to-date shop is well stocked. Under current conditions, you'll find it well worth your while to talk over your requirements *now* with him.



LOOK UNDER THE HIDE

"Caterpillar" fuel lines are made of cold-drawn seamless steel tubing. All lines are the same length to give identical spray characteristics at each cylinder. Able to withstand pressures of 3,000 to 5,000 lbs. per sq. in., the metal is hard yet capable of being cold-formed without excessive spring-back. The bore is free of injurious cracks and seams and has uniform diameter. Look under the hide for built-in quality.

CATERPILLAR, PEORIA, ILLINOIS

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OILFIELD ENGINES

Power tongs must always be safely suspended from the derrick and must have proper back-up lines installed. The operator should stand on the same side of the tongs as the back-up post. The other crew member should be sufficiently far from the head to be safely beyond reach of the end of the tongs if the back-up line should break. Safety covers for the opening on tube tongs prevent hands from slipping into gear teeth, and lines on the crumbies used to back up the pipe should be of adequate length to avoid undue strain with the possibility of a break.

With the rods out of the hole, the next step is to pull the tubing. The lifting nipple is made up tightly in the landing head flange and the head bolts are broken out. The string is then picked up high enough to permit the spider and slips to be installed on the head. During this initial lift and the subsequent pulling of the first single, all men must be out of the derrick and off the rig floor.

Lifting nipple and flanges are then broken out and laid down out of the way. The blow out equipment is picked up with the cat line, stripped over the top of the tubing, and set on the spider. The elevators are closed on the tubing, the blowout equipment is tied to the elevators, and tubing and preventer are raised to permit withdrawal of the spider and slips. This, incidentally, is done by two men to minimize the danger of sprain through working in the close confines of the cellar. The blowout equipment is finally lowered into place, made up evenly and tightly to the head, and the spider is installed on top. The blowout equipment must, of course, have adequate capacity to take care of any oil or gas blow, and should be regularly checked to make sure it is in shape for fast operation when required.

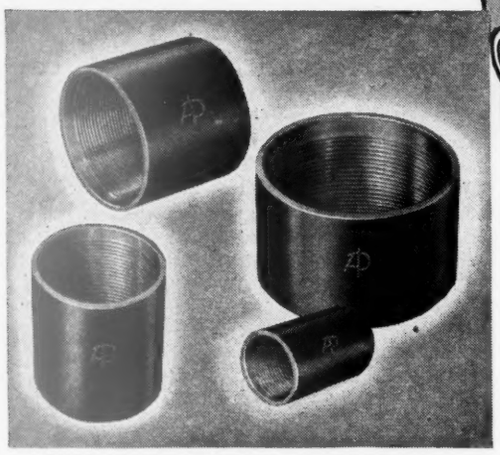
The blocks should always be steadied before starting up with pipe and the slips are then pulled and set on the spider. As the elevators reach and pass the derrick man, he puts his hand on the pipe to steady it while the stand is broken out; and as the pipe racker swings the bottom of the stand to the rack, the former pulls the stand behind the finger and releases the elevators with the heel of his hand when the stand is set down. Holding the stand out of the way with his left hand, he guides the blocks past the finger on their downward trip, being careful to keep his hands away from possible contact points between the elevators and hook or the hook and blocks.

As the elevators reach the floor, one man pulls them away from the pipe as they pass the collar and the other man pulls them in below the collar and latches the door, both again being careful to keep the hands away from contact points. Just before the load is picked up, the floorman turns the elevators so that the door is pointed directly towards the derrick man. The latter must be sure that the blocks do not strike the finger, so part of his guiding is done with the pulling line. The dead line is safe to use on one side, but the other line next to him is moving. Thus, in guiding with this line, he must use a "burner" in order to put the desired pressure on the line. The guiding of blocks is even more important when going in the hole and they are coming up empty.

Power tongs are quite an improvement over crumbies, but their operation requires the exercise of caution. As already intimated, the proper disposition of hands and adequate back-up and hanger lines are prime essentials of safety. The operator should never shift into high gear until the joint is well loosened and when putting the tongs on it requires the coordinated action of two men if strained muscles are to be avoided.

Slips should never be installed while the pipe is moving. When they are dull they should be sharpened and the slip tongs should be kept in good shape, particularly as to straight handles. Eventually slips, from continued usage, will sit dangerously low in the spider, leaving insufficient clearance between the tongs and the spider. When that happens, they should either be discarded or the backs should be built up. Although power tongs are increasing in popularity, tubing tongs or crumbies are still in extensive use. In this case, the lock must be kept engaged when in operation to prevent the tongs from falling off when pressure is released. The tongs should at all times be equipped with sharp dies, and the tool should be re-

"Since I was a boy—darned near..



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paired or abandoned when hinges become sloppy. Latches holding elevators, links in link adaptors, or hooks, must be properly used to prevent pipe hanging up and later pulling loose. If not held in tightly, it is easy for links to pump out. On old style hooks chain hobbles must be used.

When babbitting a wireline socket, the fire must be small and well removed on the leeward side of the derrick. Wire may be cold cut with the exercise of care, but it is better to use a regular wire line cutter, and goggles for the operator are in this case demanded. With the socket prepared, the end of the sand line is pulled through the oil saver and the socket. Each separate wire is then cleaned and mule-tailed, and the end of the line is pulled back into the socket. A small rag is wrapped around the base of the socket to pack off the liquid babbitt, and all is in readiness. One man holds the socket with a pair of pliers while the other pours the molten babbitt from the ladle, and both men, of course, must wear goggles. The top of the oil saver has been placed on the line ahead of the socket and they must be kept apart until after the babbitt has been poured. Allowing the bottom half to be suspended from the top half is strictly taboo. Oil savers are always handled in two parts.

When making up stems, jars, and swab, they must be well supported to avoid binding the threads, and a back-up wrench must always be held by someone to prevent slipping with dangerous consequence. In using a wrench, it must always be gripped around a section on which surface damage is unimportant. Feats of strength are definitely discouraged. It's safer to use two men on a heavy job than for one to establish a weight lifting record. When out of the hole, always use a bailing or swabbing gate in addition to the oil saver. Then run the oil saver up by hand before tightening it with a wrench and before coming out of the hole. In the process of stabbing tools into the hole use your hands only to guide them—never grip the tools!

After seating the top part of the oil saver in the bottom section, back off the packing gland and loosen the packing so that the sand line can slip freely through it. Otherwise the line might foul and pile up on the floor. No one should be near the well head when a sand line is being run in because of the danger of the tools hanging up and throwing slack loops in that vicinity. When tools and sand line are out of the hole the master valve must be closed. The old fashioned spliced eye, used with a bail top, is still employed in shallow fields and is fine for many purposes if the splice is carefully made, well tied with good, soft rope, and the end taped. A wire line must never be permitted to slip through the hands; indeed, should be touched with the hands as little as possible. A wicker can cause a serious gash and might easily, in spooling on a hoist drum, pull the hand into the drum wraps.

When tailing a polished rod in, preparatory to putting a well back on production, be sure that the stuffing box is loose and at the bottom of the rod, directly above a sub. Allowing the stuffing box to ride the polished rod with nothing but a friction hold has resulted in many a serious hand injury. The box has a habit of letting go about the time the well puller puts his hand on the rod or the pumping tee. Incidentally, stay clear of that pumping unit while it is pumping air and until proper pressure has been reached to hang the well on the beam.

In this final operation every man should be fully aware of what the other man is doing if there is to be no last minute accident. The carrier bar and locks are reassembled, and the polished rod is handled with a sub above it to the elevators so that the latter and the hook don't foul up on the horsehead. The polished rod clamp goes on, is snugged up evenly to start with, and then made up very tightly. Although a pipe wrench is fairly satisfactory for this operation, a star wrench is better. It won't slip and will safely stand a long snipe.

This, *in toto*, is a description of a specific well pulling practice. There are no doubt modifications of these general procedures that are being employed with complete satisfaction in other areas or under other conditions. They are cited here, however, because they do define safety measures to be observed in the performance of a number of commonly used techniques, and because, as we have intimated in the beginning, the safest operation and the most effective operation are the same thing. ★ ★ ★

Rugged and Handy For Small Rigs!

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Production Model

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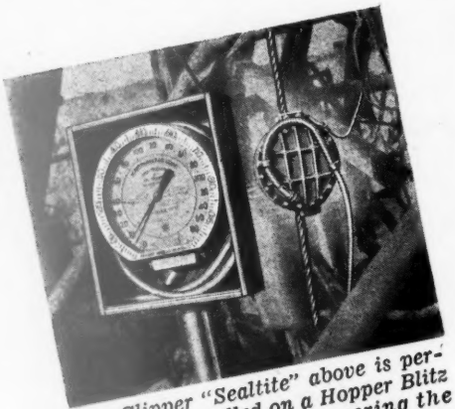

The Clipper "Sealtite" above is permanently installed on a Hopper Blitz trailer-mounted rig. Lowering the mast and moving in no way interferes with this installation.

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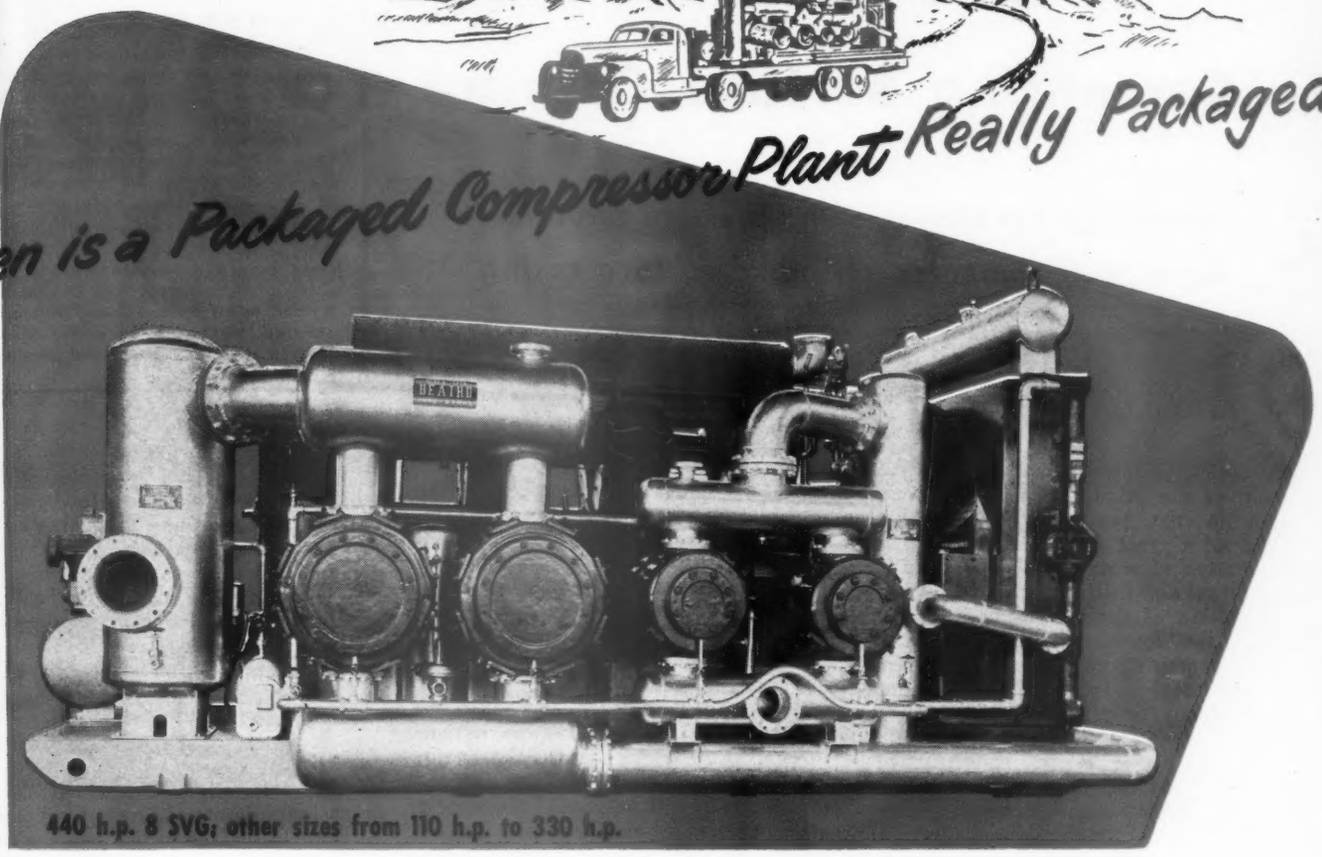

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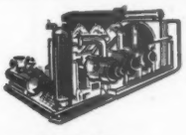

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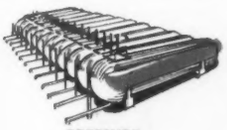


PRESSURE BULK STORAGE

Cementing Surface Casing

Guard against blowouts and pressure saturation by a well cemented string of surface casing

BRUCE BARKIS

The Author

Bruce Barkis graduated in mining engineering from the University of California in 1917. He was an officer in the Engineer Corps AEF, and on his return from overseas he worked for Shell Oil Company on early Ventura Avenue drilling. He was an engineer in the division of oil and gas engineering and field supervision with Pan American and other Doheny companies. Later he became general superintendent for Rio Grande Oil Company. With Kenneth A. Wright, Barkis formed B and W Incorporated. He has been active since 1940 in cementing and gravel packing.

DURING the last 10 years the improvement of the primary cementing operation in the productive section has received a great deal of attention. The cementing of surface casing is equally important and justifies a critical review. The string of surface casing in an oil well is the "foundation" upon which the entire producing well is constructed and should not be neglected or taken for granted any more than the foundation under a large office building.

Blow-outs and pressure saturation of sands behind the surface casing have resulted from unsatisfactory cement seals. The Teplitz-Hassebroek[1] report showing that "the usual casing cementation ends up with the annular column consisting roughly of half cement and half mud," is an obvious explanation of this situation. The expensive blow-out control equipment installed on the top of the surface casing is no more effective to control pressures than the ability of the cement seal around the bottom of the surface casing to withstand the shut-in pressures, when the rams are closed around the drill pipe.

Surface formations are, as a general rule, softer and more unconsolidated than formations at greater depth; and the surface casing serves to seal off these looser formations. Also, in many areas, these surface formations are fresh water-bearing; and their protection is most essential. The requirements for this protection are established in most cases by state regulatory bodies, and a well cemented string of surface casing is most generally specified. All other casing and tubing in the well are supported by the surface casing, for the landing heads are threaded or flanged to the surface casing assembly. This requires a resistance to large weights and high pressures.

The loss of the bottom joint or joints from surface casing that has been improperly cemented is not uncommon. Welding of the collars on several of the bottom joints has been general practice to protect against unscrewing or loss of these joints. When a large amount of mud is left in the annulus between the formation and these bottom joints, the cement seal or bond with the formations is ineffective and results in the condition shown in Fig. 1. Although centralizers may aid in centering the casing, and slightly increase the percentage of mud fluid displaced by the ascending cement slurry, they are ineffective in removing mud cake; and the cement seal between the bottom casing joints and the shale opposite these joints as shown is incomplete.

The electrical log often shows that the bottom joints, which have broken off, have dropped down the hole several hundred feet. Drilling may continue and with care, the new bit can be run through this disconnected section although there is always the possibility that the hole will be junked. In almost every case, the electrical log record shows that shales predominated opposite the bottom joints, and that the casing shoe was in an impermeable shale section.

Evidence of the incomplete cement fill obtained around the bottom joint on the usual casing cementation was established on a West Texas well recently. Centralizers were used on this installation, the lowest unit being 12 ft above the casing shoe, which had been placed in a shale section. After drilling ahead about 1500 ft, steel marks were noted on the bit. A junk trap was run, and pieces of the spring steel centralizer bows were recovered. If the cement seal around the bottom 12 ft of the casing had been effective, it would have been impossible for these steel bows to have been lost. The combination of a poor cement fill and the constant vibration of the drill pipe, rotating in the bottom joint, had loosened the casing sufficiently to cause whipping of the casing and breakage of the spring steel bows.

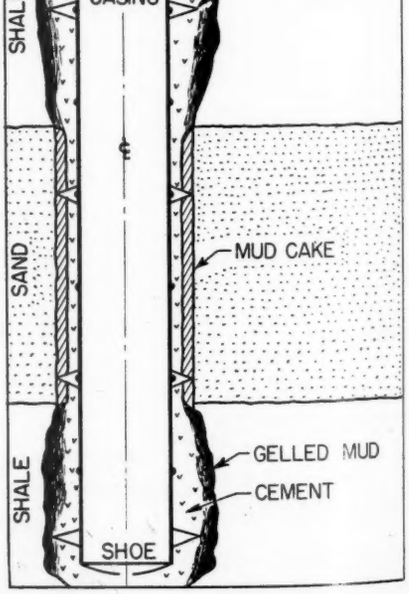
Drilling

There is very little information on the exact thickness of mud cake opposite the different formations in rotary drilled wells. The permeability of the formations, quality of mud, differential pressure, and other factors control the thickness of the cake. The measurement of the mud cake formed in the mud-testing apparatus on the surface is only relative, and does not indicate the actual thickness of the cake opposite different formations.

Examination of the cores taken with side-wall sampling devices show a large variation in the cake thickness in the same well. It is not uncommon to find thick cakes—as much as 1 to 1½ in.—on permeable sands, and thin cakes are the rule on shale sections. (See Fig. 2) Caliper surveys often show the hole diameter in sand sections to be "close to gage." The mud cake in these sections, as shown by sidewall samples, is firm and often semi-hardened because of the action of the drill pipe during rotation, and may be sufficiently stable to hold the calipers away from the actual formation.

The following table shows the increasing differential pressures at greater depth. On surface formations, the lower differential pressures influence the character of mud cake that is formed on the sandy sections. Mud cake scratched from these formations on a cement job where circulation is continued until returns from bottom reach the shale shaker, show that the mud

FIG. 1. Incomplete cement fill and poor bonding shown with surface casing bottomed in shale.



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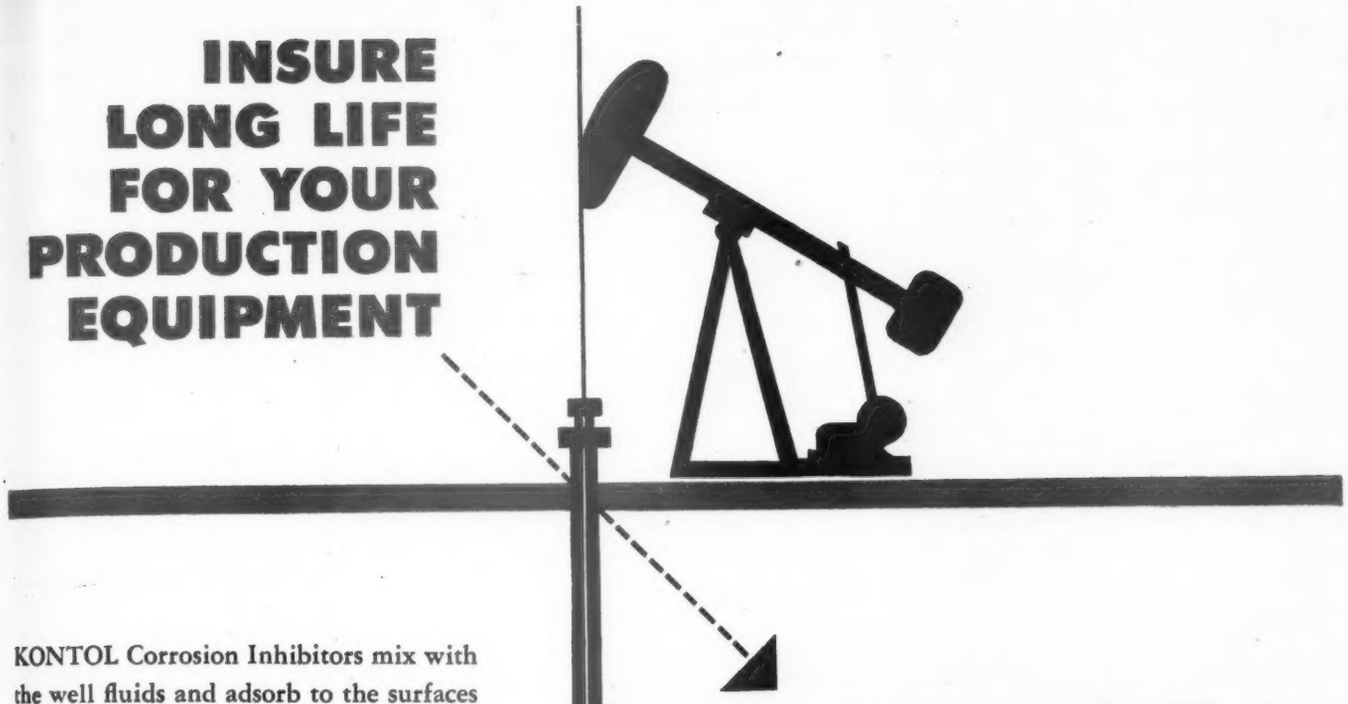

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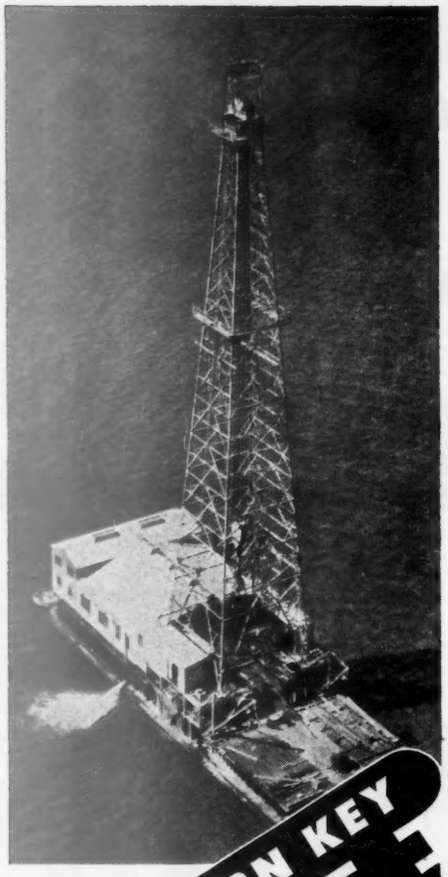

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cake is not as dense as the cakes returned from greater depths.

Differential Pressures

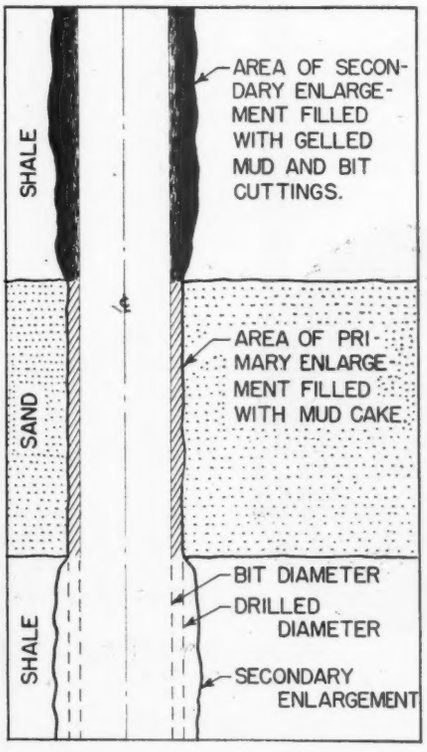
Depth, ft.	Normal Pressure, psi	Pressure w/10 lb mud psi	Difference psi
500	217	260	43
1,000	434	521	87
2,000	868	1,042	174
5,000	2,170	2,604	434
8,000	3,472	4,166	694
10,000	4,340	5,210	870

As a general rule, the mud that is used to drill surface hole is not so well conditioned or treated as when the productive section is reached, and for this reason the thickness of the mud cake on the permeable sand sections may also be greater. Inspection of the mud cake on the shale shaker shows that there is a great variation in the type of cake that is recovered, from different depths in the same well or in different wells in the same field.

The hole drilled below the conductor casing is seldom the exact diameter of the bit. Hole enlargement may be either caused by the eccentricity of the bit, because of its unbalanced design, or due to the misalignment of the drill collar and drill stem. In the upper fresh water sands some hole enlargement may also be caused by the jetting or hydraulic action of the mud fluid stream.

As shown in Fig. 2, there is additional or secondary enlargement in the shale sections below the transition zone from fresh water to salt water. This enlargement is due to the chemical action of the infiltrated water on the bentonite or soluble materials. Caliper surveys taken as drilling progresses have shown the rate of increase of hole diameter.

FIG. 2. Mud cake formation and relation of hole diameters.



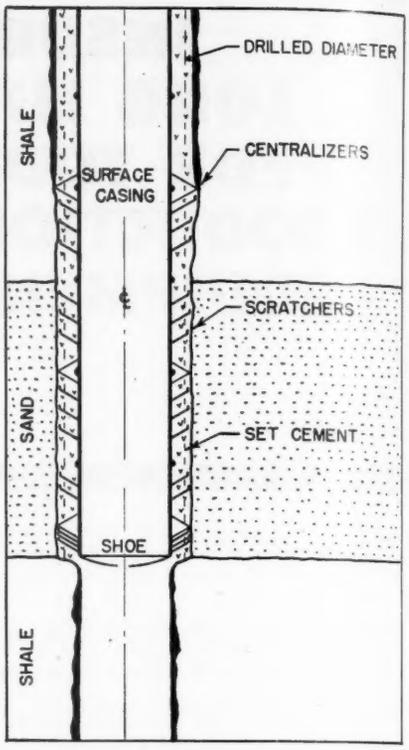


FIG. 3. Mud removal in sand section results in denser set cement around bottom of surface casing.

Current Cementing Practice

The present practice of selecting a firm impermeable shale (Fig. 1), shell or other hard formation as a seat for the surface casing, is undoubtedly responsible for certain types of casing failures.

On many locations a fixed amount of surface casing is trucked to the casing rack, and an equivalent amount of hole is made, regardless of the type or character of the formation on bottom. This procedure may be possible on some established field locations, but is definitely not recommended for wildcat or deeper and higher pressure areas.

Cementing studies have shown that the bonding of cement with the formation is more complete when the excess water used in mixing the cement slurry can be filtered into the cleaned permeable formations. The bonding of cement with impermeable shales, shells, limestones, or with mud sealed sands cannot be as complete as with a permeable section from which the mud cake has been completely removed.

Mud Displacement and Cement Placement Velocity

A detailed study was made by Howard and Clark[2] in 1948 of channeling, mud displacement, and removal, and the effect of varying rates of flow of the cement slurry. Their conclusions included the suggestion that cement slurry should be displaced in the upper laminar or turbulent velocity range (5-9 ft per second).

The average cement displacement velocity on a typical oil string installa-

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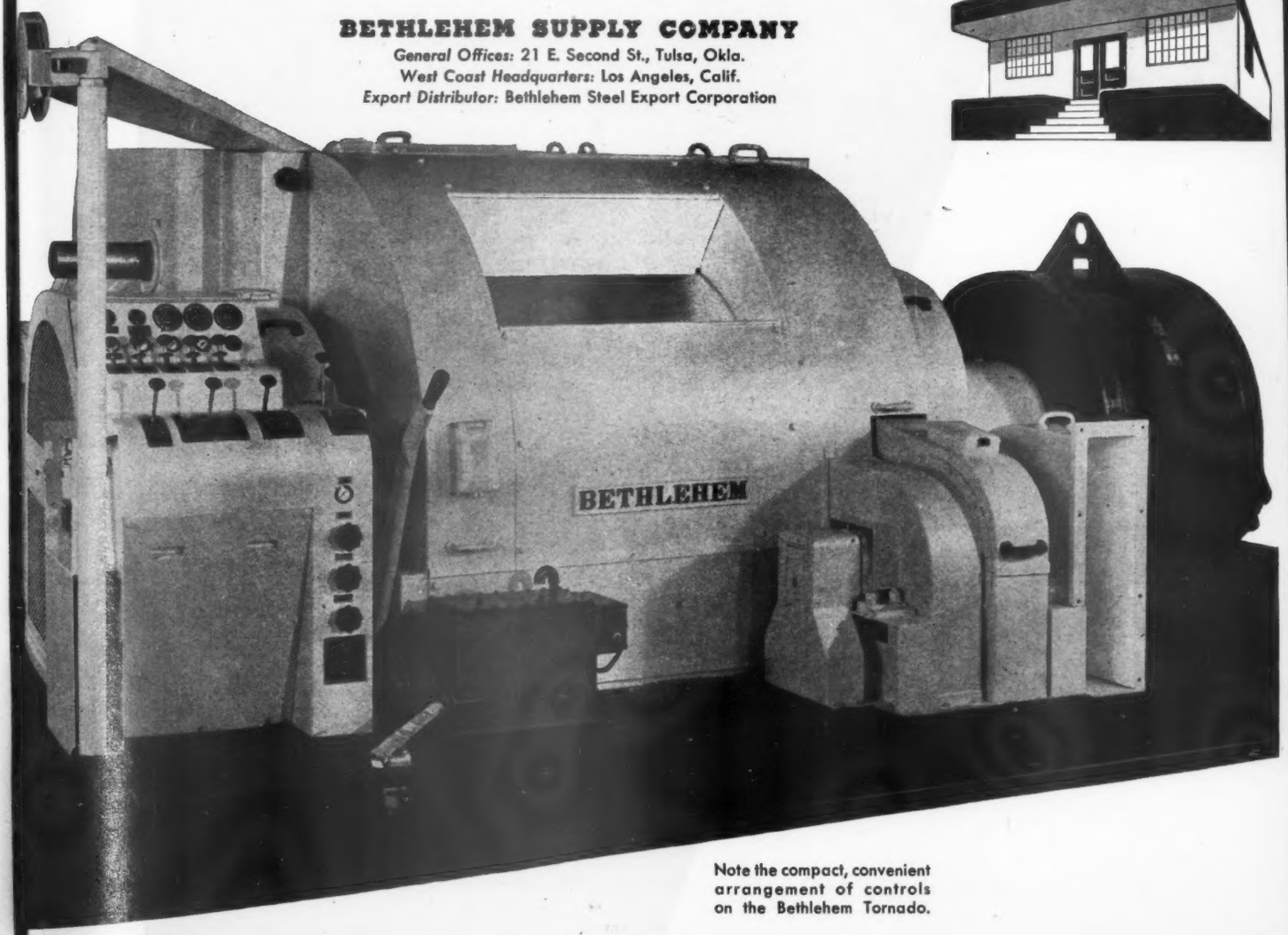

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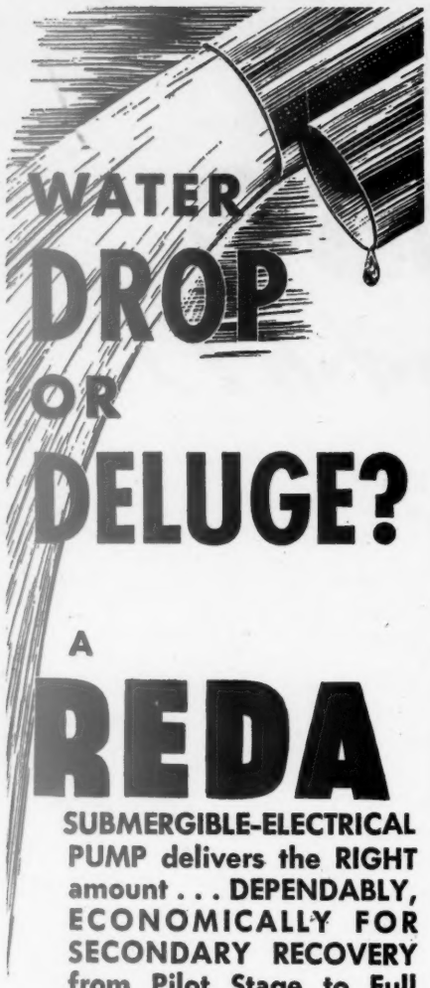

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tion is 2.5 ft per second. This velocity results from the fluid displacement obtained in the average rig pumping installation, and in such casing/hole size combinations as 5½ in. casing in 8¾ in. hole, or 7 in. casing in 9⅞ in hole.

As the capacity of the rig pumps, which are generally used to displace the cement slurry, is constant it is evident that the velocity of the ascending cement slurry in the large hole around surface casing is only a fraction of the velocity obtained in cementing an oil string. The annulus area of a 10¾ in. installation in 15 in. hole is 68 sq in. compared to the 30 sq in. around a 5½ in. casing in 8¾ in. hole. The usual upward velocity of cement around surface casing is in the range of 1 ft per second or less, which is in the transition phase from plug flow to laminar flow. Channeling of the cement slurry at this velocity can definitely be expected.

Cement Mixing

Until recently, straight cement slurry has been used for cementing surface casing. The amount of water normally used to mix neat cement slurry has been greatly in excess of the amount actually required to hydrate the cement particles. This large excess of mixing water is used to make the slurry pumpable and can only be disposed of by filtration into the permeable formations, and this filtration is only possible if the mud cake has been removed from the sand face.

The usage of additives in cement slurry has been a comparatively recent development. Bentonite, in percentages ranging from 2 to 14, has been used for reducing the slurry weight and in preventing lost circulation. The reduction of the amount of free water or water voids left in the cement column because of the water required to hydrate the bentonite is an added advantage.

More recently the addition of perlite to the cement slurry, in comparatively large amounts, has resulted in slurry weights as low as 11½ lb per gallon. This slurry weight is only slightly higher than the weight of the average drilling fluid and does not create high differential pressures that would "break down" the surface formations. The cellular structure of the material permits fairly large amounts of free water to be taken up from the cement slurry when subjected to pressure.

On many surface casing jobs it is advisable to cement around "to the surface." Low weight cement slurries are a positive requirement when this is necessary, and the usage of additives has greatly simplified this practice.

Proposed Surface Casing Cementing Practice

The installation in Fig. 3 shows the surface hole drilled through a sand section and just in to the top of shale. The grouping of scratchers and centralizers, on the bottom several joints, in the standard pattern of five scratchers and one centralizer on the bottom joint, and three scratchers on each range three joints above, with a centralizer installed at the rotary table around the next few alternate collars will condition the hole as casing is run, and also provide for mud removal from the sand section during the mud circulation period, and of more importance, while the cement slurry is being placed.

Cleaning of the mud cake from the sand face will result in well set dense cement around the bottom casing joints with the casing firmly anchored to the formation.

The installation of scratchers and centralizers on the bottom several joints of the surface casing tends to "sweep" the hole and break up the gelled mud in the enlarged hole sections as the casing is run. This action of the scratchers combined with displaced mud circulation, caused by the downward travel of the float-equipped casing, is helpful in conditioning the entire hole.

The upward traveling cement slurry only displaces mud fluid that is in motion in the annulus, and although the entire mud cake cannot be removed from the sand sections and gelled mud from the shale sections, unless scratchers are installed for the entire length of the casing string, the action of the scratcher and centralizer installation, while casing is run, will greatly increase the percentage of cement fill throughout the entire hole.

References

1. Teplitz-Hassebroek—1946—API, "An Investigation of Oil Well Cementing."
2. Howard-Clark —1948—API, "Factors to Be Considered in Obtaining Proper Cementing of Casing."
3. Smith—1950—AAODC, "Surface Casing Failures."
4. Grossman—1950—AIME, "Factors Affecting Cementing of Casing in Rotary Drilled Holes."

* * *

Two Awarded Humble Fellowships

Two University of Oklahoma graduate students have been awarded Humble Oil and Refining Company fellowships for the 1951-52 year, Dr. G. L. Cross, O. U. president, announced. They are Earl Graham Watkins, Oklahoma City, petroleum engineering recipient, and Jack Gordon Blythe, Wichita, Kansas, geology winner.

Watkins holds a bachelor of science degree in petroleum engineering from O. U. and is working toward a master's degree. When a high school junior and senior, he received the Joseph Hester Patterson award for sportsmanship and leadership.

Now a candidate for the doctor of philosophy degree in geology at the University of Oklahoma, Blythe holds a bachelor of arts degree from the University of Wichita and a master of science from Northwestern University.

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The Relationship Between Electrical Resistivity and Brine Saturation†

LEE S. CARTER*

OPTIMISM in the quantitative use of the electric log has been revived within the last several years, primarily as the result of the work of G. E. Archie[1]. This work was based on the estimation of interstitial water in sands from resistivity data. Even though the general trend of thought on the quantitative value of the electric log is optimistic, it is inevitable that the validity of such quantitative estimates are subject to differences of opinion.

For example the following equation expresses the relation between brine saturation and resistivity of a reservoir rock:

$$S^n = \frac{R_o}{R} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Where:

S = per cent brine saturation,
R_o = resistivity of the sand at 100 per cent brine saturation,
R = resistivity of the sand at any brine saturation,
n = saturation exponent.

The value of "n" in the above equation has been a controversial subject from the beginning of quantitative interpretations.

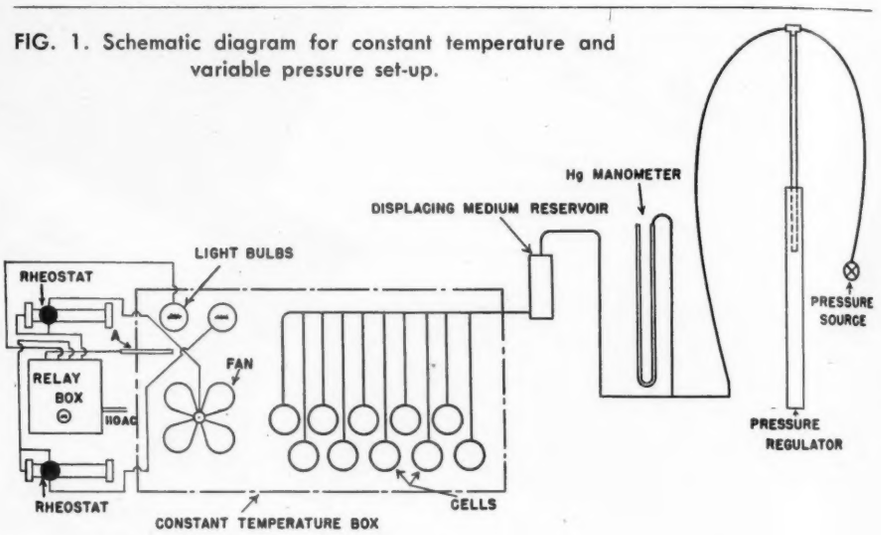
With due consideration to the divergent opinions on the subject, consider an ideal reservoir—a reservoir having a homogeneous distribution of clean sand grains throughout. Obviously, the material making up the sand body such as silica offers an infinite resistance to the flow of an electrical current as compared to the resistance of the connate water it contains, for the latter is a strong electrolyte. Thus, an electrical current in a sand body moves easily through the tortuous paths of the highly conductive pores, but negligibly through the solid sand grains of low conductivity. It is not difficult, therefore, to visualize the possibility of a relationship between the saturation of the brine and the conductance of the sand body. As the water saturation within the interconnected pore channels of a core decreases, the avenue open for the movement of ions is decreased, and thus the resistance of the sand body increases.

It is a reasonable assumption that the value of "n" can not be constant except when the solid portion of the reservoir is entirely non-conductive. If the rock matrix acted as a conductor, the value of "n" would, of course, depend upon the conductivity of the rock matrix as well as the conductivity of the brine. Because of the above, this investigation was concerned with resistance measurements on small clean sand and alundum cores.

With the knowledge that a relation between brine saturation and resistance to an electrical current exists in a reservoir rock, and that there exists a definite variation of water saturation with height above a free water table in a reservoir, one author[15] has concluded that the resistivity in the transition zone is a linear function of depth. Because both the capillary pressure and resistivity depend to some extent upon the configuration of the pores, it is reasonable to assume that there is a relationship between resistivity and capillary pressure, but as is shown in this paper, resistivity does not vary linearly with depth in most cores.

Basically the equipment used for this investigation included a constant temperature box (Fig. 1), flow lines, saturation resistivity cells (Fig. 2), and an electrical circuit for measuring the voltage drop across the cores (Fig. 3).

FIG. 1. Schematic diagram for constant temperature and variable pressure set-up.



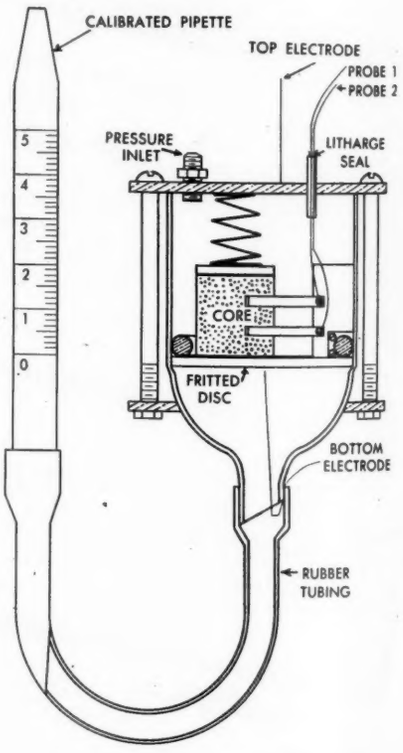


FIG. 2. Saturation-resistivity cell.

EXCLUSIVE

†Summary of thesis for Master of Science Degree in Petroleum Engineering from The University of Texas.

*Valuation Engineer, Bureau of Internal Revenue, Dallas, Texas.

[1]All references are at the end of this paper.

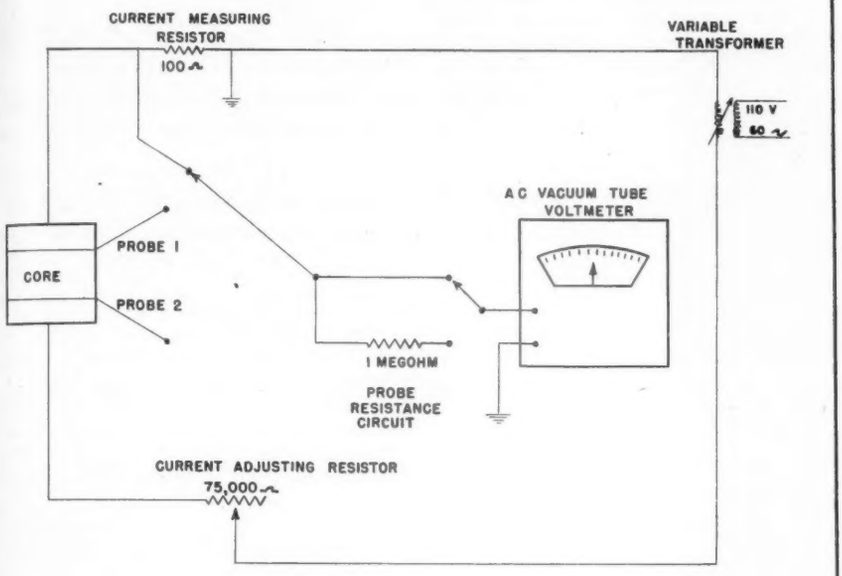


FIG. 3. Circuit diagram for resistivity measurements.

TABLE 1.—Results obtained from consolidated samples.

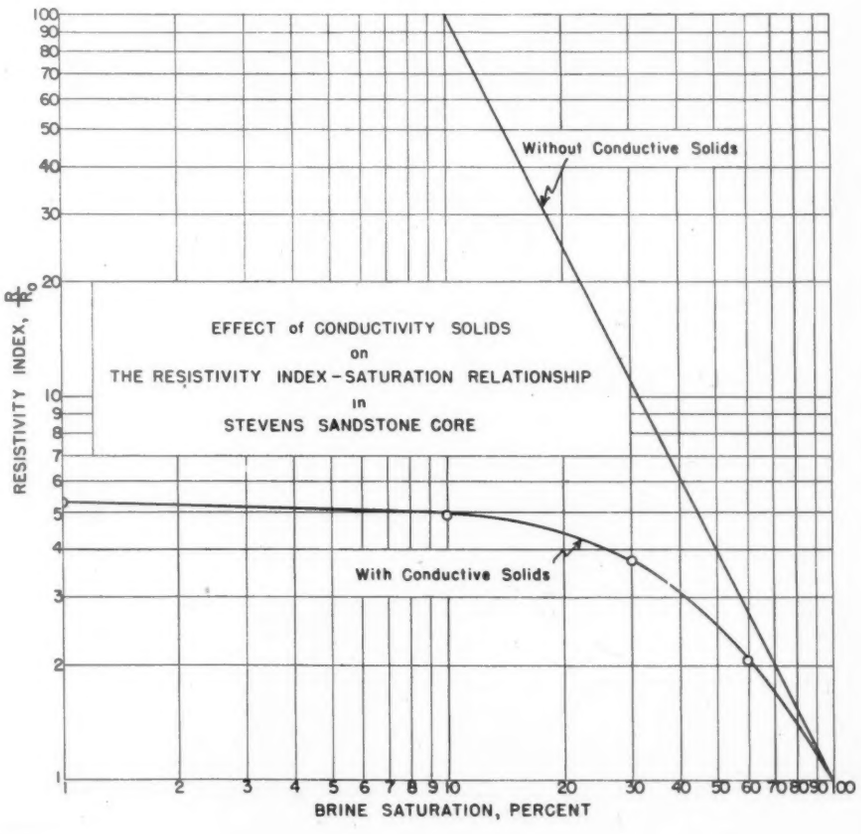
Core number	Porosity per cent	Permeability (md)	Run No.	Saturation exponent "n"	Per cent deviation from average "n"
S-1A	29.3	60	1	1.81	5.73
S-2B	30.4	500	1	1.80	5.21
S-3A	25.5	256	1	1.85	3.64
S-3A	25.5	256	2	1.91	0.52
H-3	26.7	2820	1	2.17	13.00
H-5	28.5	388	1	1.89	1.56
H-7	29.1	2880	2	2.35	22.40
H-8	28.0	2670	1	1.90	1.04
H-10	23.9	316	1	1.63	15.10
H-10	23.9	316	2	1.78	7.29
H-11	24.8	1349	1	2.02	5.21
H-14	25.5	1195	1	1.90	1.04
H-16	27.2	1952	1	2.00	4.16
H-17	28.8	258	1	2.00	4.16
H-19	26.3	1695	1	2.29	19.25
H-20	27.2	2047	1	1.85	3.65
H-21	27.9	1495	1	2.09	8.85
H-22	21.6	1141	1	1.87	2.60
H-28	24.6	1205	1	1.97	2.60
H-29	21.3	123	1	1.72	10.41
H-30	17.2	182	1	1.68	12.50
H-32	26.0	624	1	1.61	16.12
H-33	25.5	1565	1	2.15	11.98

After a core analysis was run on each of the samples to be tested, they were wired and cleaned thoroughly. The cores were then dried and seated inside the saturation resistivity cells, after which they were saturated with a brine solution by pulling a vacuum inside the cells, which were filled with brine. The brine was then removed, and the cells were filled with kerosine; they were allowed to remain under these conditions until complete equilibrium was established in the cores. The cells were then connected to a pressure manifold, and pressure, saturation, and resistivity were recorded for each of the step wise increases of pressure until the kerosine had broken through the fritted disc or until the cores had reached their "irreducible" minimum saturation.

In the quantitative interpretation of electric log data it is essential to know both the saturation exponent, "n", in the relation $S^n = \frac{R_o}{R}$ and the formation factor, which is defined as the ratio of the resistivity of the formation when saturated with brine to the resistivity of the brine. This concept implies that the formation factor for any given rock is constant regardless of the resistivity of the brine or solution; therefore, the saturation exponent for any given rock would be constant without regard to the resistivity of the brine or solution. After the work of Patnode and Wyllie[12] it is seen, however, that this can be true only when the rock matrix is wholly nonconductive. Reservoir rocks may contain clay or shale at almost any saturation, so they probably influence the determination of the saturation exponent because of their conductance when saturated. If a reservoir rock contained wet clay or other conductive solid it is apparent that the total conductivity of the rock would be the sum of the conductivity of the water in the pores and the conductivity of the solid material. In some cores, therefore, the conductivity of the solids appreciably reduces the resistivity of the core which will be shown is a function of saturation. It is clear then that the value of "n" will vary with the amount of conductive solids present in the core. In view of the foregoing, this investigation was carried out with clean sand and alundum cores. Fig. 4 from Patnode and Wyllie shows the variation between two hypothetical resistivity index-saturation curves. One effect of conductive solids is to give a resistivity index-saturation curve that could be interpreted in terms of variable and ridiculously low values of the index "n".

The average saturation exponent of all the cores analyzed in this investigation was 1.92 (Table 1). The exponent varied from 1.61 to 2.35; these two values of "n" represent a per cent deviation from the average "n" of 16.1 per cent and 22.4 per cent, respectively. The results of the determination of "n" show that 74 per cent of the cores exhibited a

FIG. 4.



saturation exponent of 2.0 or less. Although the mean average of the exponent was found to be 1.92, the data show clearly that the exponent "n" does not have a constant value of about 2.0 as is sometimes assumed. It follows, therefore, that the exponent may be considered as some function of rock texture. Wyllie and Rose[17] pointed out in their theoretical development that the exponent would vary with the rock texture and with saturation of the brine. It was apparant from the majority of the cores analyzed that the exponent does not vary with saturations down to the "irreducible" saturation for any one particular core, but that the exponent does vary from core to core.

Logical reasons for the high value of "n" reported by Williams[16] are due to the pecularity of the texture of the cores studied or due to his conclusions, which may be based on erroneous resistivity measurements of cores.

Dunlap[4] used constant displacement pressures for his measurements and only the final points were brought to resistance equilibrium with time. This was done because he was of the opinion that the saturation exponents determined from points at different saturations found the value of "n" constant regardless of the saturation. Wyllie and Rose, on the basis of their theoretical work, concluded that the exponent "n" would vary with the saturation of the wetting phase itself. They presented the following analytical expression for the exponent "n":

$$n = \frac{\log_e S_w^2 \frac{T}{T_e}}{\log_e S_w^2} \quad . \quad . \quad . \quad . \quad (2)$$

Where:

S_w = the wetting phase saturation as a fraction of the pore volume,

T = the tortuosity of the porous medium at 100 per cent wetting phase saturation and defined as the square of the ratio of the mean actual pore length to bed length,

T_e = the effective tortuosity, similarily defined, for the saturation, S_w.

Clearly, if "n" is to be a constant independent of saturation, then $\frac{T}{T_e} = S_w^{x-2}$; where x is a constant having the value of 2n. They further add that the ratio $\frac{T}{T_e}$ for any particular saturation as shown above may be related in some cases, but do not think it is universally true of all porous media. It is expected that $\frac{T}{T_e}$ would vary with pore size distribution because of the tendency for the wetting phase to be displaced first from the larger pores.

Sometimes "n" may vary with saturation; however, upon the examination of a typical curve, Fig. 5, the value of "n" found did not in general vary with saturation, and when it does, it does not seem to have any particular quantity or direction for its deviation. The writer is of the opinion, therefore, that the deviations of "n" that were found are due more to the inaccuracy of the work than the saturation at which the core came to equilibrium.

As was discussed above, a correlation definitely exists between the water saturation of a porous medium and its resistivity. Leverett[10] has demonstrated that a definite variation of water saturation with height exists above a free water table in a reservoir. Consequently, some authors[3,11,15] believe that a correlation should be found between height in the reservoir, or depth measured from the surface, and the resistivity

FIG. 5.

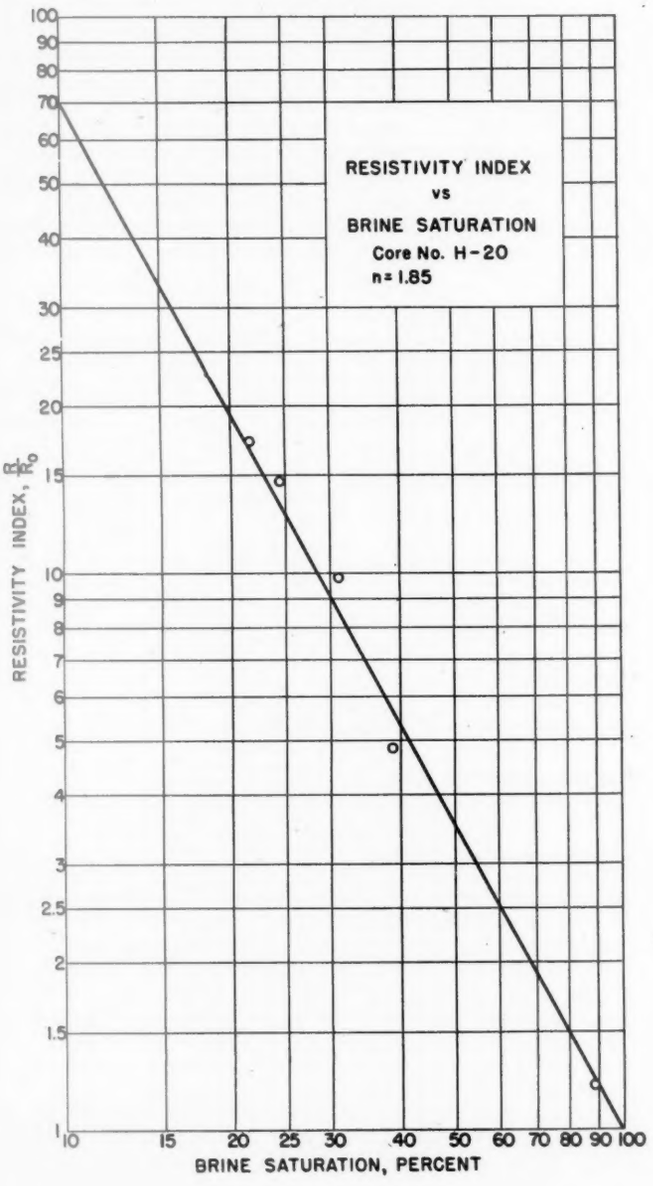
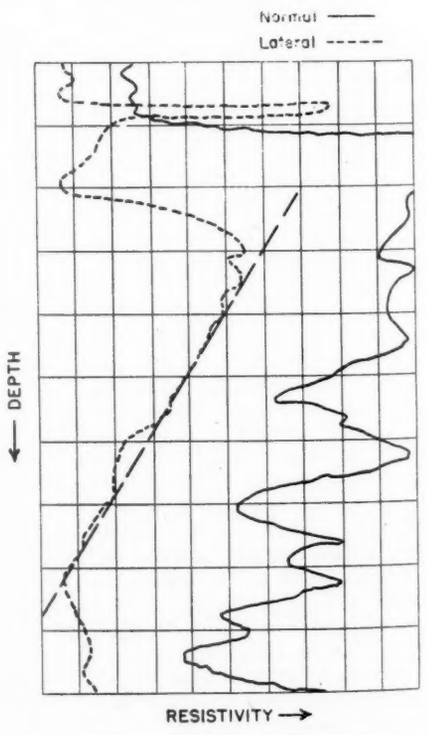


FIG. 6. Example of linearity between depth and resistivity.



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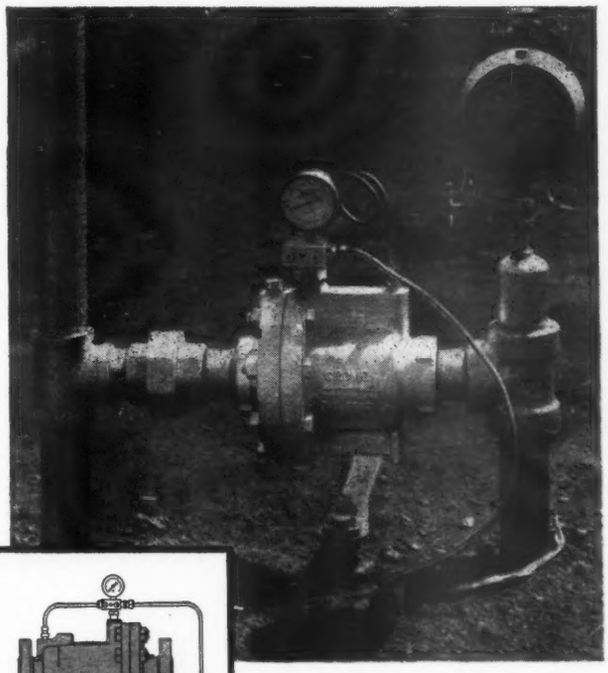

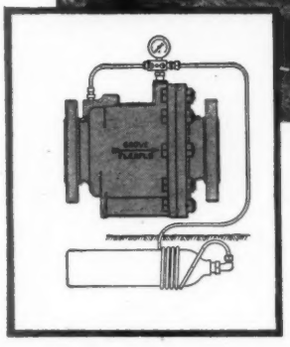

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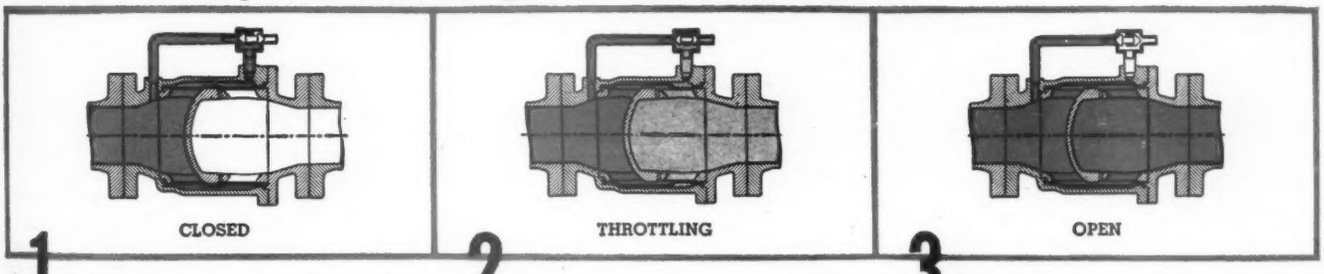

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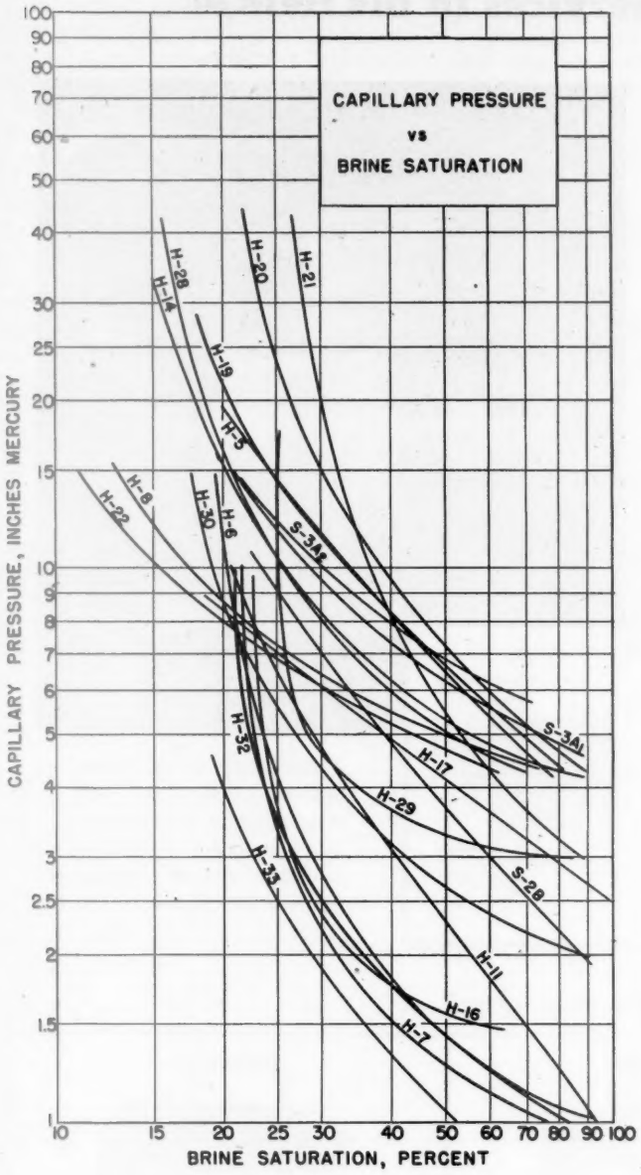


FIG. 7.

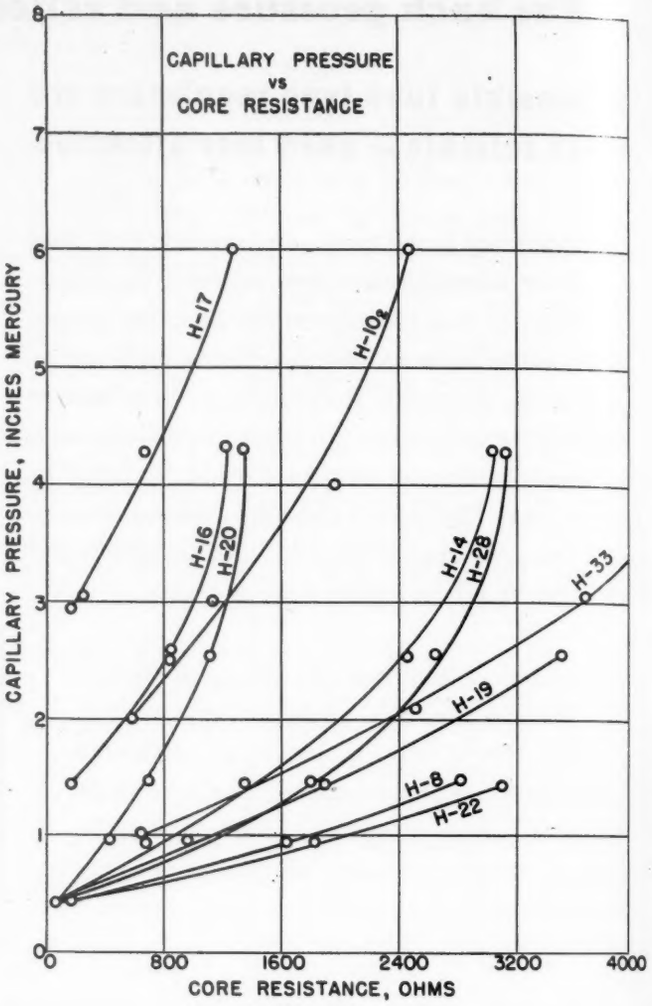


FIG. 8.

measurements where ever a free water table exists. Tixier[15] is of the opinion that the resistivity in the transition zone is a linear function of depth, and substantiated this through the use of several electric logs, (Fig. 6). Analyzing the data taken for this paper, it does not seem reasonable that in general a linear relationship exists between resistivity and height above a free water table.

For example, as was first presented by Archie, the relationship between resistivity and brine saturation can be given by the following equation:

$$\log R = \log R_o - n \log S_w \quad . \quad . \quad . \quad (3)$$

Where:

R = resistivity at partial water saturation,

R_o = resistivity at full water saturation,

S_w = fractional water saturation,

n = saturation exponent.

In order for a linear relationship to exist between resistivity and brine saturation, a graphical relationship between capillary pressure and water saturation would have to produce a straight line on logarithmic paper. Its equation would be as follows:

$$\log h = \log a - b \log S_w \quad . \quad . \quad (4)$$

Where:

h = depth measured positively upward from a reference point, a, at which S_w is equal to unity,

a = a reference point,

b = a constant of undetermined nature,

S_w = fractional water saturation.

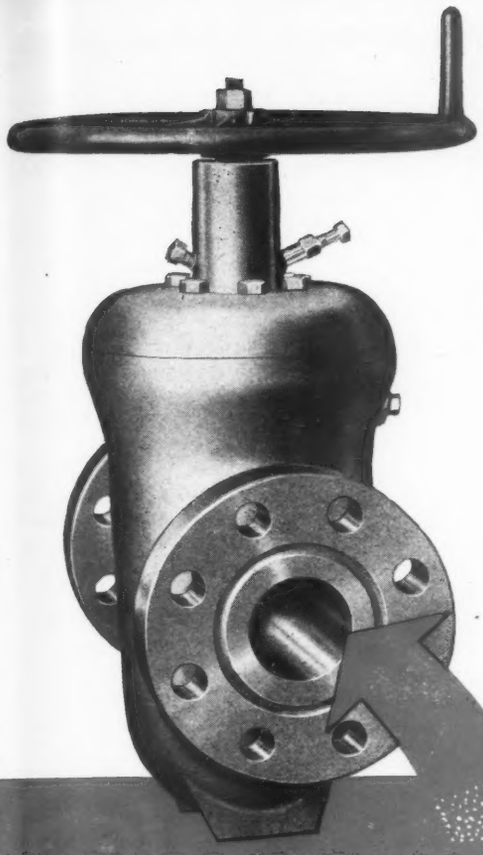
Combining Equations (3) and (4) to eliminate water saturation gives:

$$\log h = \left(\log a - \frac{b}{n} \log R_o\right) + \frac{b}{n} \log R \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Clearly, it is reasonable, the value of R should be constant where the value of the water saturation is constant and should vary where the value of the water varies; therefore, the variation of Equation (5) should be primarily through the water-oil transition zone.

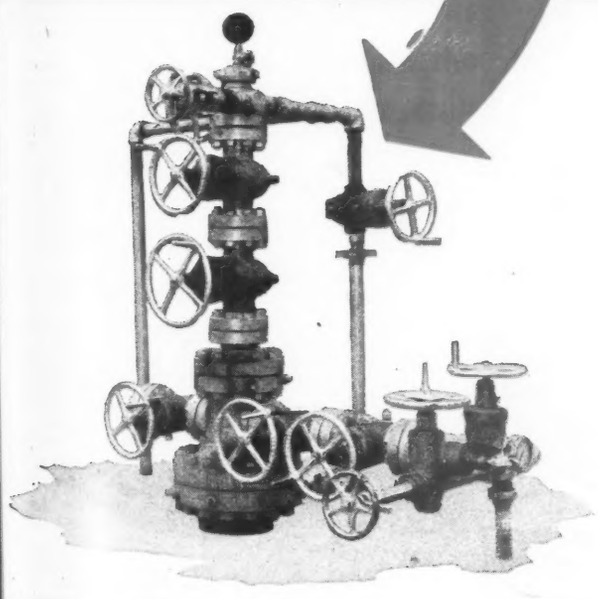
It can be readily seen that if "b" and "n" were equal in Equation (5), then a linear relationship would exist between resistivity and height in the transition zone. As shown in Fig. 7, however, log capillary pressure or log height above the water table versus log brine saturation does not produce a straight line with a definite slope for most cores. It is therefore concluded that inasmuch as log R/R_o versus log brine saturation does not plot as a straight line that resistivity could not possibly be a linear function of depth except for a few cores. Although log capillary pressure versus log brine saturation does not produce a straight line, the average slope of all the curves was taken and found to be 1.32. Inasmuch as the average slope of the log resistivity index versus log brine saturation was 1.92, the slopes "b" and "n" would not be equal even if the log capillary pressure versus log brine saturation did consistently produce straight lines.

The necessary assumption that the slopes "n" and "b" are equal does not seem to be substantiated from these results; however, the belief that they are related in some unknown manner is reasonable because they both depend, to some extent, upon the configuration of

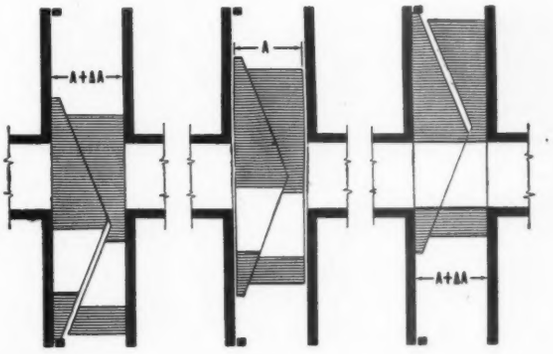


NO TURBULENCE HERE

means long valve life... low maintenance here



W-K-M Valves have a perfectly smooth bore which has about the same resistance to fluid flow as an equivalent section of smooth wall pipe. There are no cavities or projections to cause destructive turbulence or to collect sediment. The gate and the seats are fully protected against cutting or damage of any kind. These operating advantages are a result of the W-K-M Expanding Gate development which is illustrated below.



In closed position, the gate (left) and segment (right) seal tightly against both seats.

When opening or closing, the gate and segment are in neutral position, permitting free upward or downward movement of the gate assembly.

When open, the gate and segment again seal tightly against both seats and the bore of each lines up perfectly to provide a smooth, turbulence-free passage.

The W-K-M Expanding Gate design also provides free-running opening and closing under full rated pressure and gives extremely high seating pressures. For easy operation, W-K-M valves also have superfinished stems, double thrust bearings and precision ground stem threads.

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the water phase within the porous system.

Capillary pressure versus core resistance, Fig. 8, clearly shows that in a few cores there is a linear relationship between them, but the majority of cores do not show a linear relationship. This is to be expected since the slopes of "b" and "n" are not the same and in most plots of log capillary pressure versus brine saturation produced a curved line.

In summary, the value of "n" varies with the different textural properties of each core, and was found to have a minimum value of 1.61 and a maximum value of 2.35 with an average value of 1.92.

Although the value of "n" did not deviate directly with saturation as the saturation was reduced for the cores examined, it is theoretically reasonable to believe that "n" will vary with saturation.

It is doubtful that the relationship between capillary pressure and resistivity is linear for most cores because the saturation exponent, "n", was not found to vary from core to core, and further because the plot of log capillary pressure versus log saturation produced a majority of curved lines with an average slope of 1.32. Also, the plot of capillary pressure versus core resistance did not produce a linear relationship in most cores.

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Are jet rock bits successful? Under certain conditions they have proved their value—Their use is spreading from East Texas and Gulf fields to all North and South America

ERNESTINE ADAMS*

IT is remarkable what a comparatively simple change in the design of drilling bits is doing to drilling operations these days. The new bits are equipped with nozzles positioned to the bit so as to direct high velocity drilling fluid to the bottom of the hole instead of low velocity fluid against the teeth of the cutters on the blades of the bit. You wouldn't call it a radical departure from the old design yet the jet bits have proved many times that they can cut drilling time in half and can reduce the number of bits used by a fourth.

The name "jet" is used appropriately because the fluid is forced through nozzles at high pressure. The jetting action disintegrates and carries off cuttings so effectively there is no power wasted on recutting, and avoids the teeth of the cutters so there is less wear on them. Some engineers add that the jetting prewets the formation for easier penetration; others say this is unproved.

*Managing Editor.

Background

Back in the days when only cable tool rigs were in operation, water was put in the hole to wet cuttings and hold them in suspension until the fluid became so heavy and viscous the drilling bit action got very logy and could not work. Since there was no circulation, the tools were brought up and the fluid removed by bailer. Then the drilling bit was run down the hole with another supply of water.

Rotary drilling introduced circulation of drilling fluid through the drillstem and out the annulus by pumps, which were small and provided only low pressure. This method probably increased the rate of penetration and it eliminated the time-consuming bailing operations.

Every step in drilling advance has been in the direction of more efficiently disintegrating and removing the cuttings

EXCLUSIVE

Jet subs applied to Reed bit.

so that all the energy of the drill could be applied to virgin formation and none dissipated on rotating and working on cuttings that have not been taken from the bottom of the hole.

About 20 years ago the idea of jetting the fluid from bits was advanced and some experiments were made. There were two obstacles: (1) the low pressure, low volume pump in use at the time and (2) the unavailability of high erosion-resistance material from which to make the slush nozzles. Steel, glass, enamel, rubber, and other materials were tried but could not withstand the abrasive action of the drilling fluid under high pressure and high velocities.

The success of jet bits awaited the introduction of larger pumps and other equipment to apply greater fluid pressure at the bottom of the hole and of the hard resistant alloy, tangsten carbide, to withstand wear of the high velocity fluid at the jet, or nozzle.

Experiments

When the big drop in demand after World War II failed to materialize and supply of oil products very nearly lost a close race with the demand, drilling men began more diligently than ever to seek better tools and better methods for their operations. They had the task of drilling more wells, deeper wells, and drilling them in a shorter time. How was this to be accomplished?

One of the answers was the jet drilling bit.

Humble Oil and Refining Company took the lead in laboratory research on jets and pushed field tests. Other companies responded with tests of their own and equipment manufacturers worked with the oil companies.

For some time the jet principle was confined to drag bits as it was generally believed that fluid velocity on the bottom would not materially benefit rock bits. Another obstacle was the design of the rock bit, which made adaptation to jet action a difficult problem. Supply of jet rock bits is still tight because of problems involved in converting mass production methods to this type of bit.

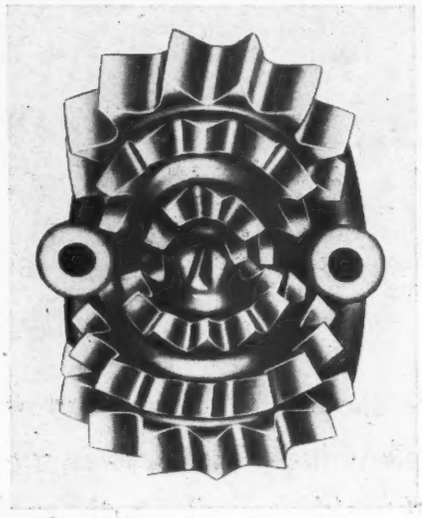
The drag bit was fairly easy to convert and standardized models were soon on the market. Their success was spectacular under good conditions, which included the important item of increased slush pump power. The engineers most experienced in use of jet bits, however, say that increased slush pump power is definitely not a prerequisite for the satisfactory utilization of jet bits; that more efficient utilization up to the rated capacity of the pumps is the key to the application of jets.

With what they had learned about jet drag bits, operators and manufacturers turned to rock bits. The jet sub appeared first along the Gulf Coast. This substitute jet was applied to the conventional rock bit and provided a good tool for testing.

In an ordinary rock bit the drilling fluid circulates at a relatively low nozzle velocity through the water courses of the bit. It is discharged through short broad nozzles directly onto the cutters, in an attempt to remove cuttings from between the teeth. Some formations, however, especially those of a sticky consistency, tend to pack the teeth and ball up because the drilling fluid does not have the pressure to remove the cuttings. Energy is thrown away on washing and wearing the teeth instead of disintegrating and removing the cuttings. When the cuttings form a gummy mass the bit has to redo the work it has already done; it keeps on recutting the cuttings.

Tests of jet rock subs showed impressive results. They did fine in soft formations, which usually called for drag bits along the Gulf Coast (jet drag bits are more economical in formations that may be drilled with them, according to some Gulf operators). The jet rock subs scored in medium formations, and later surprised operators by increasing the drilling rate in medium hard and even hard formations, although by smaller percentages.

Leading drilling bit manufacturers put their engineers to work on integral jet rock bits, and within the comparatively short time of two to three years they have the efficient new design on the market in two-cutter, three-cutter, and four-cutter types. The tests carried out by Humble and other companies helped determine the new design.



Two-roller jet bit of
H. C. Smith Oil Tool Company.

Standard Models

The integral jet sizes in some types now available from stock are:

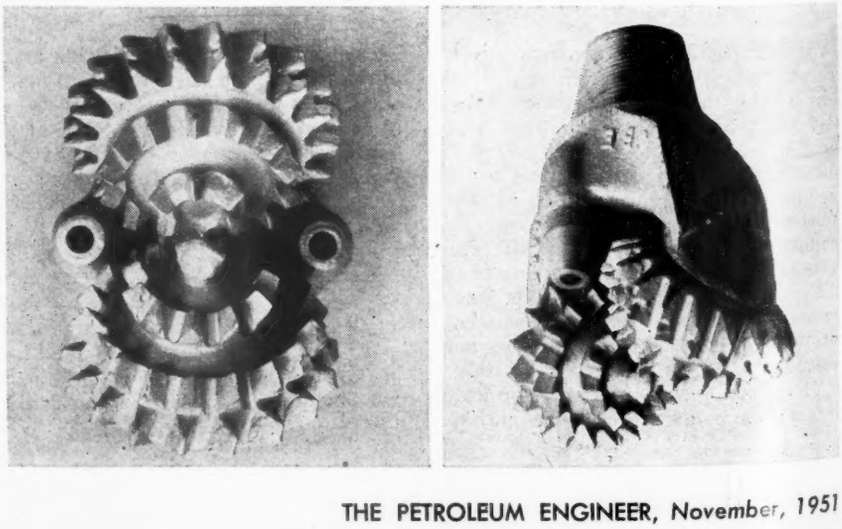
Two-cutter in 8½ in., 8⅝, 8¾, 9, 9⅝, 9¾, 9⅞, 10⅝, 11, 12¼, 13¾, and 15 in.

Three-cutter in 8⅝ in., 8¾, 9, 9⅝, 9⅞, and 12¼ in.

Four-cutter in 7⅞ in., 8⅝ in., 8¾ in., 9 in., 9⅞ in., 11 in., 12¼ in., and 13¾ in.

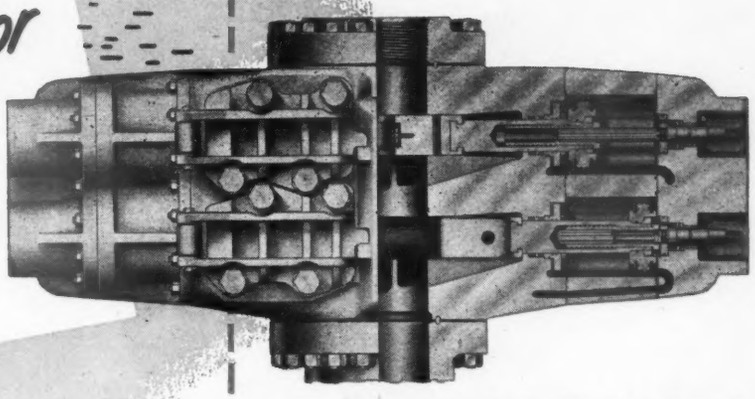
The principal material from which jet bit water courses are made is tungsten carbide or alloys of this material with cobalt, chromium, boron, etc., providing longer service by withstanding the severe abrasion of high velocity fluid.

Two views of Globe Oil Tools Company jet rock bit.



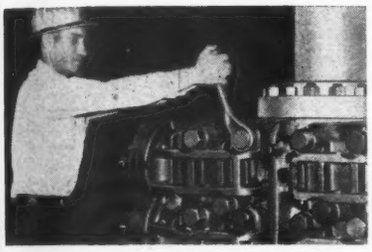
In this gate Simply Swing Open a Door to Change the Rams!

...whether pipe is in or out of the hole!

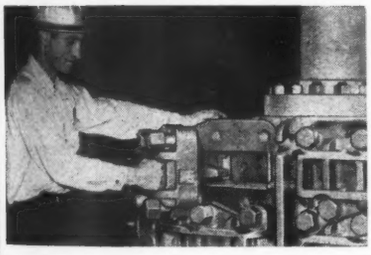


The Shaffer Hydraulic Double Cellar Control Gate (above) combines two separate ram compartments in ONE *body for maximum compactness. The Shaffer Hydraulic Single Cellar Control Gate is also available, if desired.*

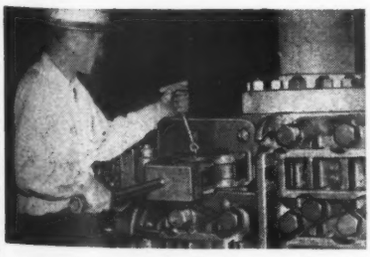
SHAFFER HYDRAULIC CELLAR CONTROL GATES make ram changing as simple as this...



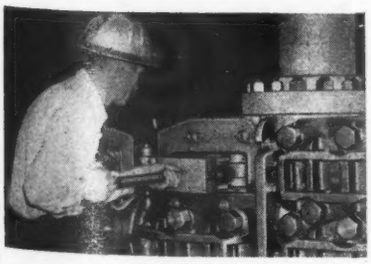
1. UNBOLT TWO DOORS in the side of the Gate by simply loosening four bolts in each door. The bolts remain in the doors where they won't be lost.



2. SWING THE DOORS OPEN and pull out the ram assembly. There is nothing to manually unlock and disengage—the complete ram assembly pulls right out.



3. LIFT THE RAMS from the Gate and replace the ram blocks and rubbers with others of the desired size—a quick and easy operation.



4. SLIDE THE RAM ASSEMBLY back into the Gate and bolt the doors. Guide ribs on the doors automatically align the ram assemblies as doors close.

AND NOTE THIS—*since the rams are changed from the side—not the end of the Gate, you can make a complete ram change with equal ease whether the pipe is in or out of the hole!*

Unequalled speed and simplicity in changing rams is only one of the many major advantages designed into Shaffer Hydraulic Cellar Control Gates. Other unique features are briefly outlined at right, but be sure to get the *complete* story on this Shaffer product before you buy *any* cellar control gate equipment. *No other equipment provides so much protection—in so small a space—with so many vital advantages!*

FOUR OTHER VITAL SHAFFER ADVANTAGES

Amazing Compactness—The Double Gate combines *two* separate ram compartments unitized into *one* body with an overall height of only 30" even in sizes as large as 13⅜" (12" Series 900). The Single Gate of like size, with one ram compartment, is considerably less in height than any other hydraulic gate on the market, measuring only 18½" high overall!

Fully Enclosed Design—with all moving parts, including piston rod ram shafts, completely enclosed within the body of the Gate. There are no outside moving parts to become wedged or damaged by objects falling into the cellar—or become corroded by chemical and salt drippings. Even the locking shaft is non-rising, fully protected!

Direct Hydraulic Drive—with the hydraulic operating cylinders *directly behind* each ram for maximum simplicity and safety. There are no complicated indirect connections between hydraulic cylinders and rams!

Quick Draining Body—with the rams traveling on high narrow guide ribs above the steeply-sloped bottoms of the ram compartments. Mud and sand quickly drain back into the well—no detrimental accumulations to interfere with free ram travel!

These and still other vital advantages combine to make the Shaffer Hydraulic Cellar Control Gate the most advanced hydraulic gate available today. Before you buy *any* control gate equipment, be sure to get the complete story from your nearby Shaffer representative—or write direct.

Write for your free copy of the new 1951 Shaffer Catalog. See Shaffer section—pages 4525 to 4600—of the 1951 Composite Catalog.

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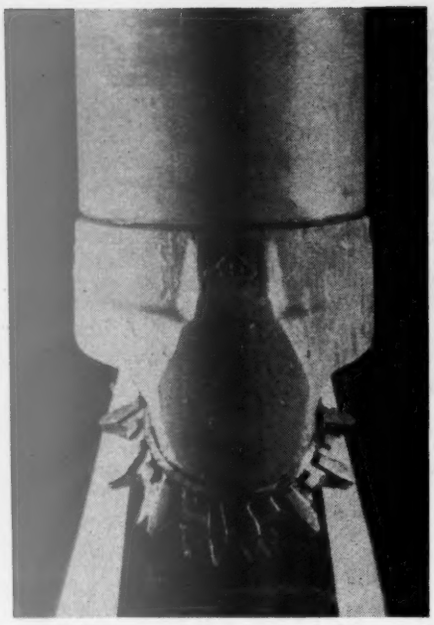
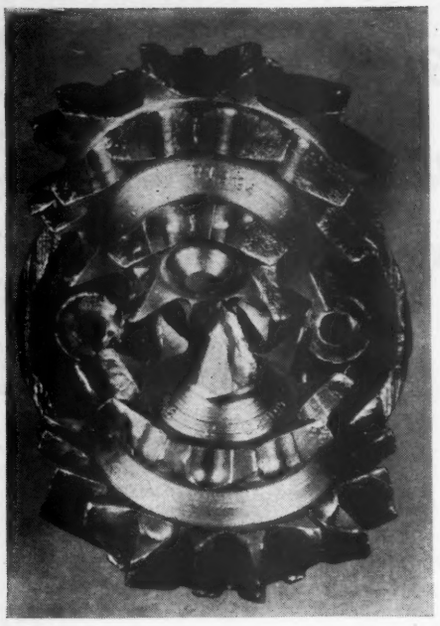
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.





Hughes two-cone jet bit jetting fluid and, right, bottom view.

not stopped operators. Local machinists in several areas convert conventional rock bits to jets for around $60 or $65 and a number of these subs are still being made and used in some hard formation areas.

Technical Know-How

The jet drilling bit has one temporary disadvantage. It requires more engineering know-how to handle for maximum results or, at least, a new set of data for determining the best conditions for efficient jet drilling. The drilling engineer has all the usual problems and must add to them the task, which is more difficult at higher pressures, of keeping the volume of formation removed in balance with the fluid pumped. The jetting action must be made to fit the slush pump power available and the minimum volume of fluid required to clean the hole. There has to be a re-assessment of rotating speed, bit weight, drill pipe sizes, mud types, etc.

Pumps

Another disadvantage is that on some rigs today the pumping horsepower can-

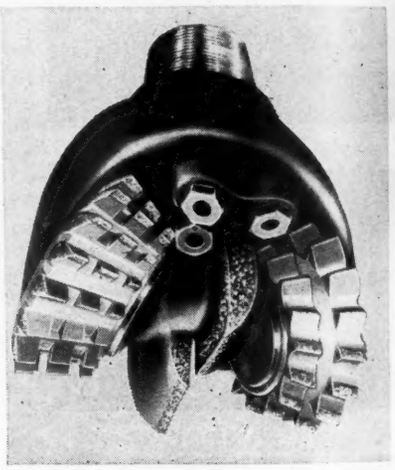
The jet nozzles are placed in various positions on the different roller types, all with the idea of maximum disintegration and rapid removal of cuttings from the bottom of the hole and of eliminating abrasive fluid action against the teeth.

Instead of a velocity of 20 to 80 ft per second of the conventional bit, the jet handles velocities of 175 on small rigs to as much as 500 ft per second on large rigs. The specially designed nozzles are usually placed so they are from 2 in. to 4 in. from the bottom of the hole.

Design research by one company[1] showed that parabolic or elliptical nozzle approaches were most satisfactory. A straight exit was found capable of maximum discharge. Heaviest impact pressure was said to result when the nozzle was as close as possible to the bottom of the hole.

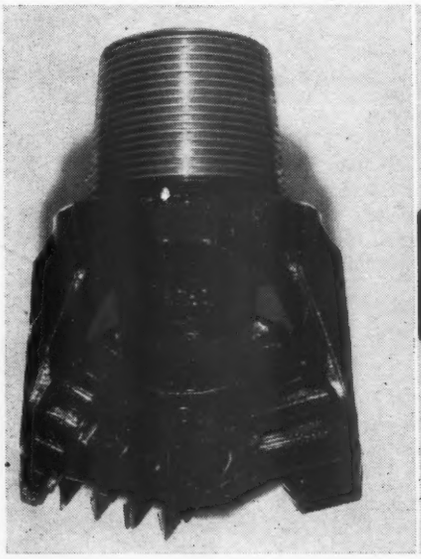
Virtually every one agrees that performance of jet bits is highly successful in such formations as clay, sticky or rubbery shale, medium to medium hard shale, conglomerate, gyp, red beds, anhydrite and other formations where circulation is important in obtaining optimum drilling rates. There is some disagreement, however, about the economic use of jets in drilling hard formations where cuttings are quite small and conventional circulation seems enough to remove them. As yet tests have not been wide enough or intense enough to answer the question finally. It has been only recently that operators in West Texas, the Rocky Mountain states, and Canada, have tried out bits on the hard formations such as dolomite, hard limestone, chert, etc., and often these trials were under unfavorable conditions. There was, however, in many cases, evidence of small reduction in drilling time.

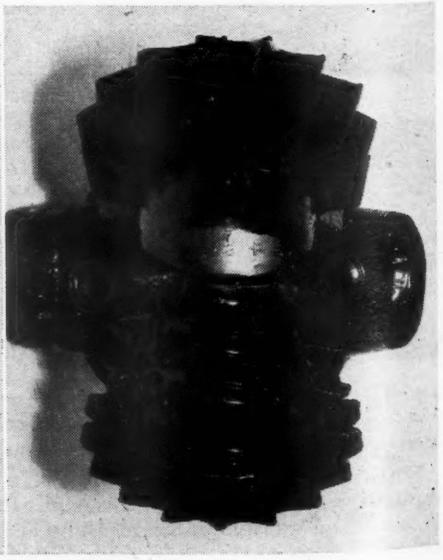
Right now and in the near future jets will get a more thorough workout in the field. Limited supply of integral jets has



Jet type drag bit and combination bit of A-1 Bit and Tool Company.

Reed Roller Bit Company calls its jet type bits "Twin Blast."





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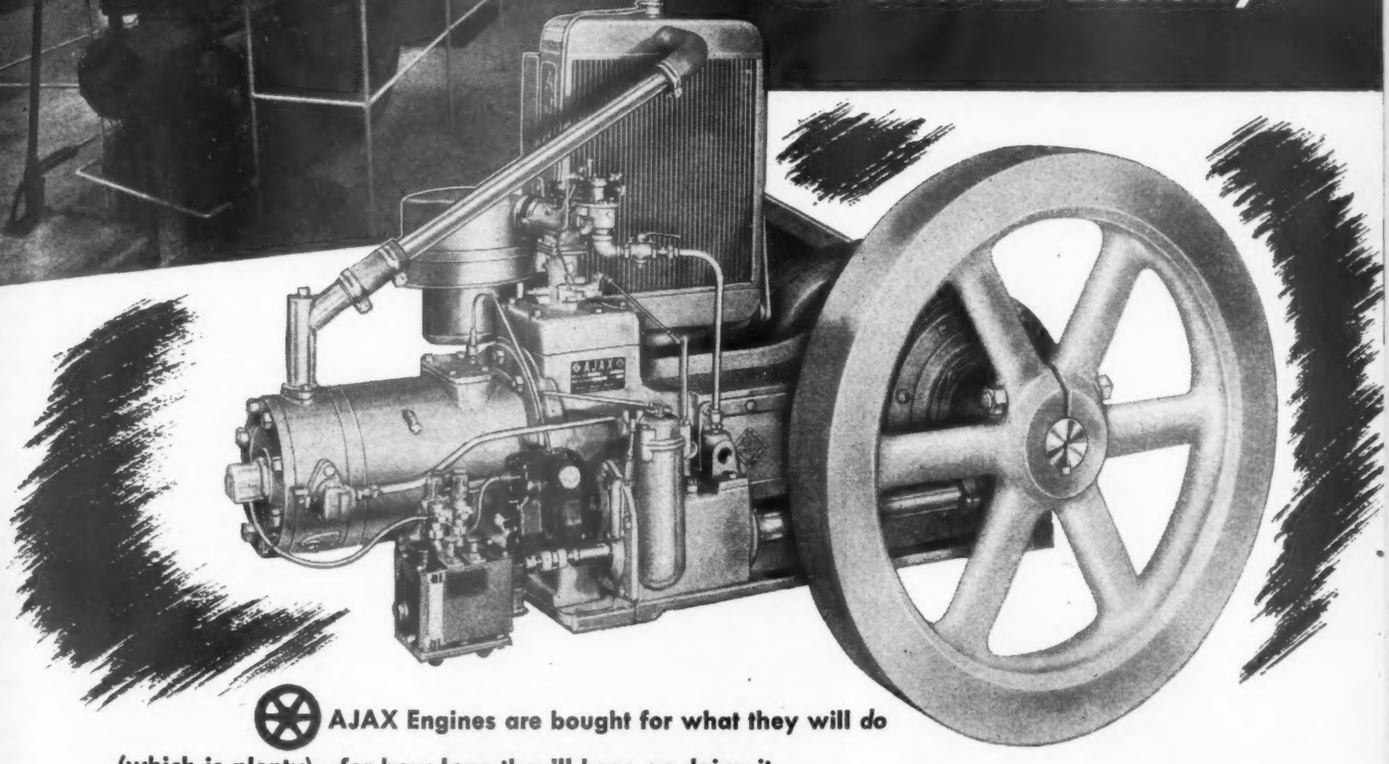

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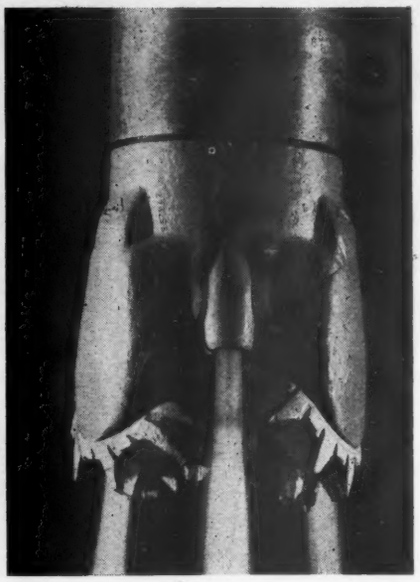
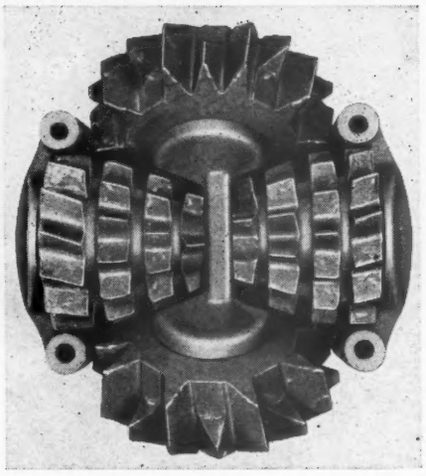


Three-quarter bottom view and action shot of Hughes Tool Company's tricone jet type rock bit.



Security Engineering Company four-cutter jet-circulated rock bit from side and bottom.

These are "before and after" using views of Reed Roller Twin Blast four-cutter rock bits.

not be increased enough to meet the needs of the jet drilling bit. There is some opinion, however, that pump power has been over emphasized as a requirement in using jets. According to this idea, hydraulic horsepower is put to work assisting the bit in digging. The minimum requirement for increased pump power is only 150-200 psi at the nozzles, which corresponds to a velocity of 150-175 ft/sec and most pumps can meet this increase.

Another manufacturer points out that the idea of the need for extremely high pressures probably came from the fact that the heavy steam rigs on the Gulf Coast, which develop extremely high pressures, were the first to use jets.

Several contractors in the East Texas area use one or two jets at the top of a hole with only 7¼ by 12 pumps, which are generally considered too small for 9-in. holes to 5000 ft. They have been able to reduce drilling time about 25 per cent for the first 3000 ft.

For maximum efficiency one equipment engineer considers pumping equipment should produce fluid velocities in the range of 175 to 225 ft per second at the nozzle and a return velocity of 150 ft per minute minimum.

At present most pump horsepower is expended in mud circulation with high pipe losses, says another engineer. With jet bits contractors have found by using bigger drill pipe, IF tool joints, or something similar, they can cut their pump horsepower considerably, even in some cases requiring less power for jet bits.

Records

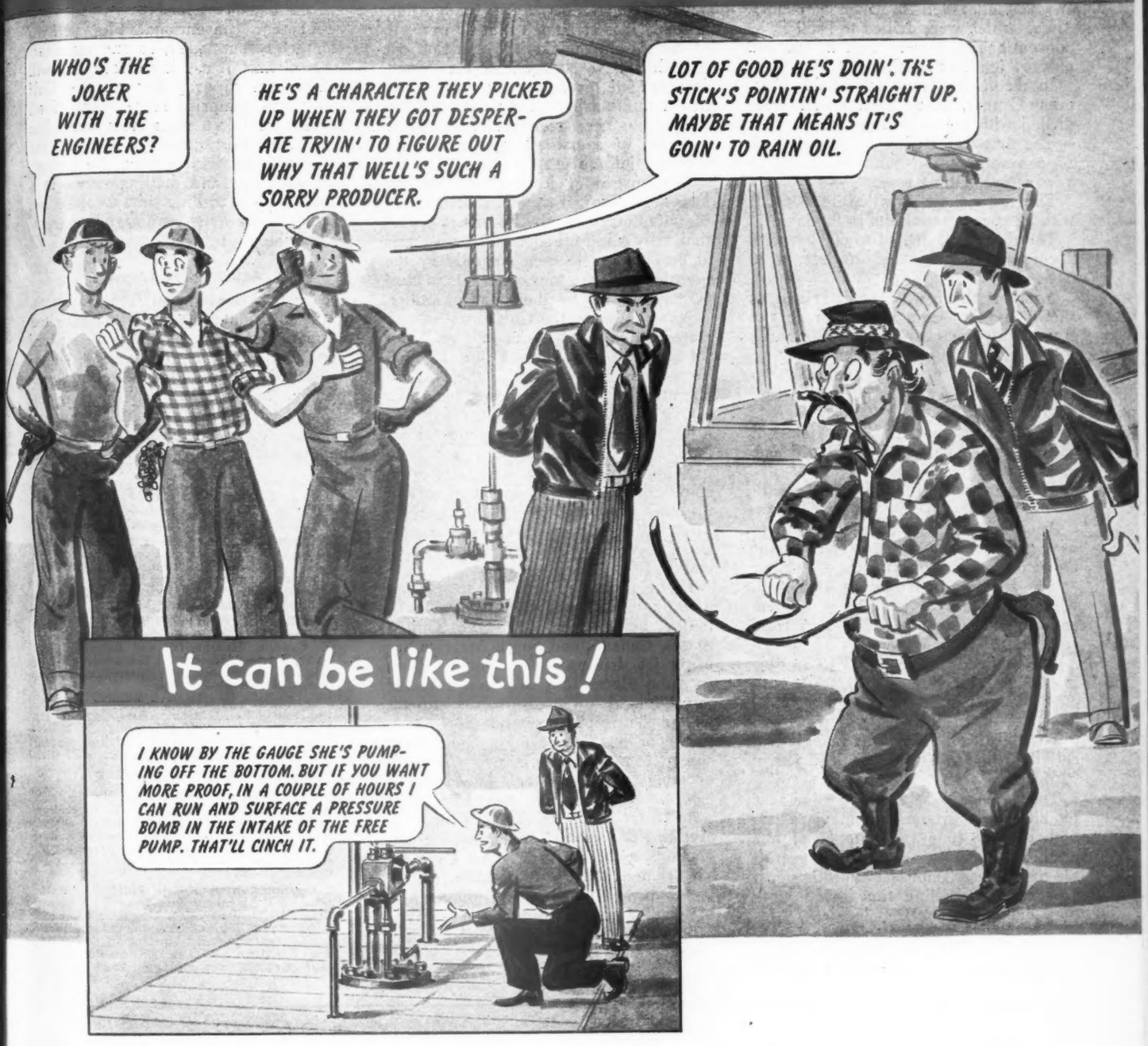
The Pickton, East Texas, field is a sort of home field for the jet rock bit. Humble conducted some of its early jet rock bit tests there and other operators followed. With its uniform formations and numerous operators, the field was a good spot for controlled experimentation. Under conventional drilling, wells in the field required about 55 drilling days and 45 bits. Jets brought this average down to 27 days and 25 bits. Of the 10 rigs now in the field 8 rigs use only jets and the other 2 rigs use both jets and conventional.

Results of some controlled tests on the massive anhydrite and Green Rose beds of East Texas showed that a third less jets were required than conventional bits to drill the same depth and the jet bits did the work in a fourth less drilling time.

In West Texas drilling time has been cut as much as 50 per cent in shale sections. In a California field where straight hole was more important than time two-cutter bits with light weight nevertheless made a 15 per cent decrease in drilling time. On the other hand, some West Texas experiments were inconclusive. One oil company found little difference in records of four wells drilled with jets and one well drilled with conventional bits.

The fact that fewer jet bits are required on a job is also important, because the jet costs from $22 to $30 or

It doesn't have to be this way...


WHO'S THE JOKER WITH THE ENGINEERS?
HE'S A CHARACTER THEY PICKED UP WHEN THEY GOT DESPERATE TRYIN' TO FIGURE OUT WHY THAT WELL'S SUCH A SORRY PRODUCER.
LOT OF GOOD HE'S DOIN'. THE STICK'S POINTIN' STRAIGHT UP. MAYBE THAT MEANS IT'S GOIN' TO RAIN OIL.
It can be like this!
I KNOW BY THE GAUGE SHE'S PUMPING OFF THE BOTTOM. BUT IF YOU WANT MORE PROOF, IN A COUPLE OF HOURS I CAN RUN AND SURFACE A PRESSURE BOMB IN THE INTAKE OF THE FREE PUMP. THAT'LL CINCH IT.

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more higher than the conventional bit. In two similar wells in Anderson county, Texas, which were drilled to 9650 ft, 59 conventional bits were used in one and only 44 jets in the other.

In the Richardson-Caddo field, Montague County, Texas, similar wells were drilled with the following results:

The first well drilled to 5856 ft with 27 conventional bits and 5 jets in 15 days actual drilling time.

The second well drilled to 6067 ft with 32 conventional bits in 22 days.

The third well drilled to 6083 ft with 7 conventional bits and 16 jets in 20 days.

Another three-way comparison is shown by the same contractor in the Haynesville-Smackover field, Claiborne Parish, Louisiana. Here:

The first well drilled to 10,651 ft with 102 conventional bits in 80 days actual drilling time.

The second well drilled to 10,693 ft with 45 conventional bits and 45 jets in 64 days.

The third well drilled to 10,542 ft with 22 regular bits and 54 jets in 64 days.

Another contractor in the same field used the same rig and nearly the same crews on three wells with these results:

The first well, drilled to 10,599 ft, without the use of jet bits or tandem collars, with 106 bits in 109 days from spud in till completion.

The second well, using 11 to 12 6½-in. OD collars, drilled to 10,634 ft with 30 conventional bits and 45 jets in 90 days.

The third well, using the same tandem collars drilled to 10,630 ft with 63 jets in 72 days.

There seems to be little question that jet bits when properly handled reduce both drilling time and number of bits used. The jets cost more but the overall bit cost is less. Pumping operating cost goes up but drilling time saved more than makes up for it.

Acceptance

Acceptance of the new jet drilling bits by the industry has been advancing steadily and seems to be accelerating. Already it is estimated that 90 per cent of the rigs in the Coastal area that use drag bits have changed to jets. Manufacture of jet drag bits was not held up by manufacturing difficulties and the supply has been plentiful. There is no question of overwhelming support for the new jets on drag bits.

The spread of jet rock bit drilling has been limited by limited supply. Manufacturers usually had more orders than they could fill so increased use was at first limited in area not only by the questionable efficiency of jet bits in hard formations but by their unavailability.

Now, however, the Gulf Coast is estimated to be using about half and half jet bits and conventional bits. In East Texas some 75 per cent of the rigs are operating with all or some jet rock bits.

One manufacturer estimates that 7 or 8 per cent of all bits in use are the jet type.

Manufacturers have made strides in standardizing their designs and setting up mass production tools and methods. They will soon be able to meet the market if government controls allow needed materials.

Right now drilling contractors and drilling departments of oil companies in major fields throughout the United States, Canada, and South America are using jet drilling bits to some extent. In some places they are used only for top hole and low pressure bits are put on for the deeper formations.

Use of jets is becoming more widespread in the drilling industry. In spite of some failures through lack of sufficient mud circulation, most rig crews want to try them. As in all drilling operations, the success of jet drilling bits depends upon the crew. One engineer says that in the use of jets, to remember total mud pump pressure is a limiting factor in the application of jets. Mud volume and pressure drop at the nozzle are the limiting factors in making hole. If the record of mud volume is watched and kept up, the operator will get the benefit of jet bits.

Whether conventional bits will be completely outmoded, as one manufacturer claims, or use of jet rock bits will follow that of drag bits on the Gulf Coast and comprise 90 per cent of all in use, we won't guess from here. But with materials growing scarcer, the fewer bits that are needed the better; and with rigs and drilling crews at a premium, less drilling time means a lot. On both counts the jet design apparently has the advantage.

Acknowledgment

For the cooperation I received in gathering material and for solicited opinion I want to express my sincere appreciation to manufacturers of standardized jet type bits, to drilling contractors that have had experience in the use of jet bits, and to the oil companies' drilling departments that have experimented with jet bits.

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Below is a list of papers devoted to the technical phases of the use of jet drilling bits:

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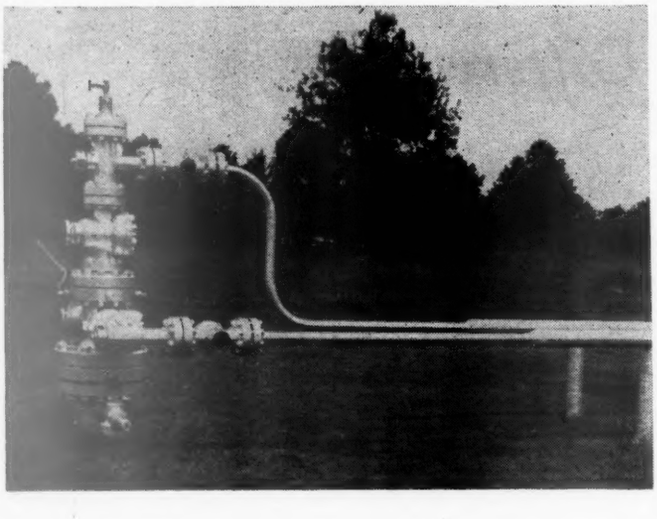
★ ★ ★

CHRISTMAS TREE FLOWS DUAL SANDS THROUGH TWO FLOW LINES



In parts of the Carthage field, Texas, wells produce from two sands and at different rates. To meter the gas flow from both sands, the christmas tree is equipped with two flow lines, each having its meter run and separate orifice meter. The well shown in the photograph produces from the deep sand through the upper branch of the christmas tree, through the reverse bend and straight run. The upper sand is produced through the casing and through the wing valve to the straight run.

Both flow lines extend for several feet with 1½-in. pipe, and then are expanded to the 3-in. meter run. This arrangement steadies the surging flow that is set up by the main valve setting, and enables the stream to reach desired meter conditions with a short run.

Beyond the twin meters, the lines are equipped with chokes, which are pinched to permit each sand to flow its desired rate. Beyond the chokes the two streams are combined in a single line leading to the separator. By choke adjustment, both flows are brought to a common pressure for the flow line.

With this dual setting either sand may be produced alone if desired without unbalancing the system or requiring meter readjustment. ★ ★ ★

Lost Circulation — Causes and Remedies†

The problem must be met on two fronts—mechanical drilling techniques and also the substance of formation being drilled

H. J. SHUMATE*

"WHAT can we do about Lost Circulation?" is a question that is becoming more common each day, as we drill ever deeper in the search for the raw petroleum necessary to maintain adequate reserves in face of the increasing demands of the national economy and the preparedness program.

As the deeper zones are penetrated with greater regularity, we find lost circulation assuming the menacing proportions of a malignancy consuming an increasing amount of rig time, man-hours, and money. Lost circulation is not new; it is as old as the rotary drilling industry that is now spotlighting it, but it becomes more serious as we are forced to greater depths and more expansive wildcatting programs to fulfill current and future needs.

Lost circulation may be divided into two classes: First, those of a mechanical nature resulting from drilling techniques employed; second, those inherent in the formation and merely awaiting penetration of the bit.

The mechanical type is considered to be an artificially induced loss, caused by employment of high density muds used for drilling abnormal pressure zones; pressure surges resulting from pipe movements, balling, high gel strengths; pumping methods, reduced annular clearances, or a combination of two or more of the conditions listed.

Losses of the second type may occur when drilling loosely consolidated sands or uncemented gravel beds, lime rocks containing solution (sometimes cavernous) porosity developed by exposure to water, and cracks or fissures resulting from earth stresses. Mechanical factors are, of course, present and exert a strong influence on the gravity of the second type of loss, though some may be held to have been unavoidable by virtue of their inherent characteristics.

In an attempt to combat the terrific additional expense of lost circulation attendant on drilling in zones of known abnormal pressure along the gulf coast of Louisiana and Texas, an intensive study of the character of these losses was begun. The most effective remedy for lost circulation is, of course, to prevent it, but before this could be done a proper diagnosis would have to be made.

It had been noted that, in many cases of loss, the hole would remain full and sometimes it was possible to restore circulation by the simple expedient of making a trip to change bits, time alone seeming to make the necessary repairs to the hole. In other instances the loss had been preceded by a perceptible slowing of the pump, indicating a restriction in the flow of the mud. These factors lent weight to the theory that fractures were being created by an excessive pressure greater than the tensile strength of some of the formations to which it was exposed.

Engineers were assigned to a test well in the Peach Point field of Brazoria County, where high density mud would be required and equipment was installed for recording mud weight, pit level, drilling speed, circulation rate, bit weight, pump pressure, pump strokes, rotary speed and rotary torque. There were 22 instances of loss recorded during the drilling of this well, and 14 were found to be directly associated with balling or movement of the drill pipe.

In the majority of these losses the hole remained full, indicating the formations were capable of supporting the 17.5 ppg mud being used, and that pressures in excess of the hydrostatic pressure were being required to rupture the formation. Information on the magnitude of pressure surges resulting from pipe movements was not available, so a decision was made to determine the connection these movements might have with mud losses.

A sub was made to replace the bit in the drill string and two recording pressure gauges were attached. Tests were run inside casing to determine effects of rapidly running and withdrawing drill pipe, spudding while pumping, and rapid opening of pumps to start circulation. Pressures obtained were equivalent to an increase in mud density of 1.3 ppg and 2.3 ppg, respectively, during rapid lowering of one stand of pipe and rapid lowering of the kelly while pumping. Pressure surges equal to one-third ppg increase over initial circulation pressures occurred when the pump was opened wide immediately on starting circulation. Pressure decreases, due to withdrawals, were not great, usually being less than 50 psi at all depths.

These surge tests were conducted in oil-emulsion muds of low viscosity, low gels and low density, and obviously would have been of a higher order in fluids of less favorable character.

As a result of the information obtained from the test wells, plans were made to employ drilling techniques that might serve to reduce the frequency of losses in the next abnormal pressure well.

The well chosen for the trial effort was J. F. Perry Unit No. 1, in the Peach Point field. Oil-emulsion mud was used to eliminate balling by preferential wetting of the drill string. Increased annular clearances were obtained by use of streamlined drill pipe and removal of the rubber protectors. Reduction in pressure surges was made possible by slowing the entry of the drill pipe in the hole from the normal 15-second-per-stand running time to 35 or 40 seconds; by starting the pumps after the kelly was lowered; by adoption of a no-spudding rule; and by slowly opening the pumps when circulation was begun.

Successful completion of the well without a single loss of circulation, as compared with a previous history of 79 losses on 3 prior wells in the same field, gave ample justification for the control methods employed.

Losses of circulation occurring in porous, cavernous, or fractured formations are difficult to avoid, sometimes difficult to cure, and, in extreme cases, have been known to result in abandonment. Losses of this type are prevalent in the Permian Basin.

At the present time the most frequent losses are encountered in the Midland Basin. The increased tempo of drilling occasioned by Spraberry, Pennsylvania and Ellenburger discoveries has resulted in this becoming the most active area in West Texas, and costs attributable to lost circulation have mounted greatly.

Wells drilled on the Central Basin Platform lose mud regularly in zones containing solution porosity, while the Delaware Basin, which has not yet been widely explored by deep wildcatting, promises to be equally interesting and difficult to drill when activity in that area increases. The majority of the deep wells drilled in the Delaware Basin have reported trouble in maintaining circulation, and some of these losses have

†This paper was presented before the Eleventh Annual Meeting of the American Association of Oilwell Drilling Contractors, at Fort Worth, Texas, September 24-25, 1951.

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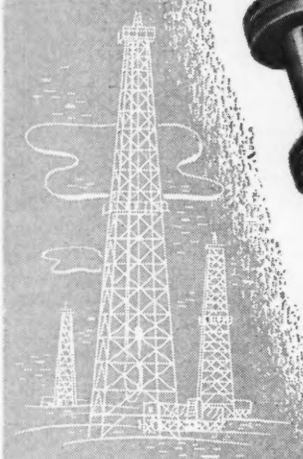

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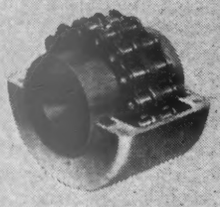

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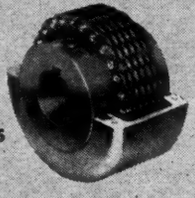

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been severe in the extreme. One well that penetrated the Ellenburger on the western side of the basin reported 46 losses, totaling 12,985 bbl of mud. Worthy of note is the fact that that particular mud never weighed over 9.0 ppg and contained at all times as much sealing material as the pumps could handle.

It has been stated before that lost circulation is either mechanical, and caused by drilling methods, or arises from conditions inherent in the formation which, in many instances, have been aggravated by mechanical factors.

Once a loss has occurred, interpretation must be made before the proper remedial procedure can be undertaken. Instruments recording pit level and pipe movements are particularly helpful in making this interpretation, but if the loss is of a serious nature knowledge of the point of loss should be obtained if possible.

The following methods for determining the point of loss have been used:

1. **Temperature Survey.** Requires forcing mud out of the hole by pumping cool mud from the surface. This method is expensive and has brought inconclusive results.

2. **Radioactive Tracer.** Carnotite has been added to the mud and pumped down the drill pipe along with remedial squeeze mixtures, followed by a gamma-ray survey. The Carnotite resulted in radioactivity being scattered throughout the mud system and wall cake, and was discontinued because of negligible results.

3. **Spinner Survey.** This method has proved most helpful, but requires large volumes of mud, and is ineffective where large quantities of sealing materials are present. It is sometimes necessary to displace the entire volume of the hole from the top with mud containing no sealing materials before a reading can be obtained.

4. **Resistivity Survey.** An electrical survey employing the principle of resistivity has lately been developed that gives promise of locating the point of loss without much waste of mud. It has particular significance in that it is not subject to clogging with sealing materials or shale particles. The author observed the use of this instrument on a well bottomed at 10,432 ft, where two points of loss were established. The first loss was from 7925-7950, and the second from 8340-8350. The survey required only two hours of rig time and 160 bbl of mud for running.

When interpretation as to cause has been made, curative measures are selected. Some of the most promising remedies are listed, not necessarily in order of importance:

1. **Sealing Agents.** The use of sealing materials is usually the first method employed, and in losses to zones of low permeability are usually adequate. Concentrations ranging from 5 to 35 lb per barrel are commonplace. More than one type is necessary to achieve a variety of patterns and an effective gradation in particle size.

2. **Equalization Cementing.** This procedure has especial significance in West Texas, where the fluid levels frequently drop considerable distances down the hole. The mud level is determined by running a float or short piece of spinning chain on a measuring line down the inside of the drill pipe. Calculation of the hydrostatic head is then made from the known weight of the mud. Tubing or drill pipe is then placed at a sufficient height above the loss so that when the cement and the displacing fluid reach a point of equalization about half of the cement will remain in the hole to be drilled out.

3. **Diesel Oil-Bentonite Squeeze.** This method necessitates use of a cement truck for mixing approximately 300 lb of bentonite per barrel of oil, and is pumped through the drill pipe to a point just above the loss where it is permitted to contact the water or mud in the hole. At contact with the water or mud the oil is forced out and the result is immediate hydration of the bentonite, which then forms a tough plug capable of sealing off a large loss.

An interesting variation consists of mixing 300 lb of gypsum cement in a barrel of oil and following the procedure outlined above. If the thief formation is a dry one, it would be necessary to pump water into the formation ahead of the mixture to provide the proper hydration fluid. This adaptation offers a way to overcome the time and temperature factors controlling the setting of this cement. As no hydration takes place in the oil, it will remain pumpable for any length of time that it is not in contact with water or mud. It is necessary to pump oil spacers ahead and behind either type of mixture, to avoid plugging the drill pipe. Best results are obtained from a ratio of 4 bbl of squeeze mixture to one of the hydrating fluid.

4. **Oil-Emulsion Muds.** One of the most important developments in the rotary drilling industry of the last few years has been the increased use of oil-in-water type emulsions for better drilling fluid control. Chemical emulsions made from water-base muds to which 10 to 15 per cent by volume diesel oil, containing a soap emulsifying agent, has been added have enjoyed signal success in elimination of balling and reduction of pipe drag, rotary torque, and circulating pressures in soft shale formations.

Emulsions have been slower to come into favor in West Texas than on the Gulf Coast, because electric logs do not give as complete a picture as they do on the coast, hence the Permian Basin geologist is forced to rely mainly on surface examination of samples and drill stem testing done as a result of this examination.

As fluorescence in the samples is one of the important conditions upon which drill stem tests are based, artificial fluorescence imparted to the samples by oil in the mud could prove costly on wildcat wells.

In field wells where geological control has been established, both stable and mechanical emulsions are gaining recognition as an aid in reduction or prevention of circulation losses. It is possible by the use of oil to maintain muds as light or lighter than water, and this is of particular significance in wells that will not even support the weight of water.

Current steel shortages have made it necessary to curtail the use of casing, and by use of crude oil to reduce weight operators have been able to eliminate the salt strings from their casing programs in some of the Spraberry sand developments. As you know, open salt sections produce a mud that will weigh in excess of 10 ppg when complemented by the formation solids. In an area where 9.0 ppg mud is the maximum fluid weight that it is possible to circulate, addition of 25 to 40 per cent crude oil and a small percentage of zeolite clay has enabled operators to achieve the drastic weight reduction necessary. A better emulsion will result if two or three pounds per barrel of starch is also added. De-foaming agents are usually necessary in these muds, the most effective of which is Octyl alcohol, and when added in a ratio of one part to 10,000 will reduce foam sufficiently to make pumping possible.

5. **Drilling With Gases.** The author was privileged to observe a well drilled with compressed air in Martin County, Texas, and also wells using gas in the San Juan Basin of Northwestern New Mexico.

On the Martin County well air was provided by portable compressors in two stages of compression and injected into the well at a rate of some 40,000 cu ft per hour. Because of the low volume it was necessary to drill by reverse circulation with 2⅜ in. tubing, and then considerable difficulty was experienced from plugging. The entire Spraberry section was drilled by this method with no liquid being introduced into the hole other than that provided by the formation itself. A total of 922 ft was made with 20 bits in 148 rotating hours.

In the Blanco gas field of New Mexico, the introduction of gas as the circulating medium has met with spectacular success. Operators were plagued with so much trouble from lost circulation in drilling the Cliff House, Menefee and Point Lookout sands in the Mesa Verde sections of the Upper Cretaceous that mud bills sometimes ran as high as $20,000, and it was felt that the wells when completed were not nearly as good as they should have been. An average of some 1,500,000 cu ft of gas per day is required for drilling and keeping the hole clean and, of course, lost circulation has been eliminated. On one well observed by the author, 822 ft of hole was made with two bits in 27¾ hours, and only 19½ hours was actual rotating time on bottom, the other 8¼ hours being spent in reaming, jetting, and making connections. Mud used on this well amounted to the ridiculously low figure of 47 sacks of Bentonite for spudding. Before introduction of gas drilling, average drill-in time with mud ranged from 10 to 14 days, and 10 to 14 bits.

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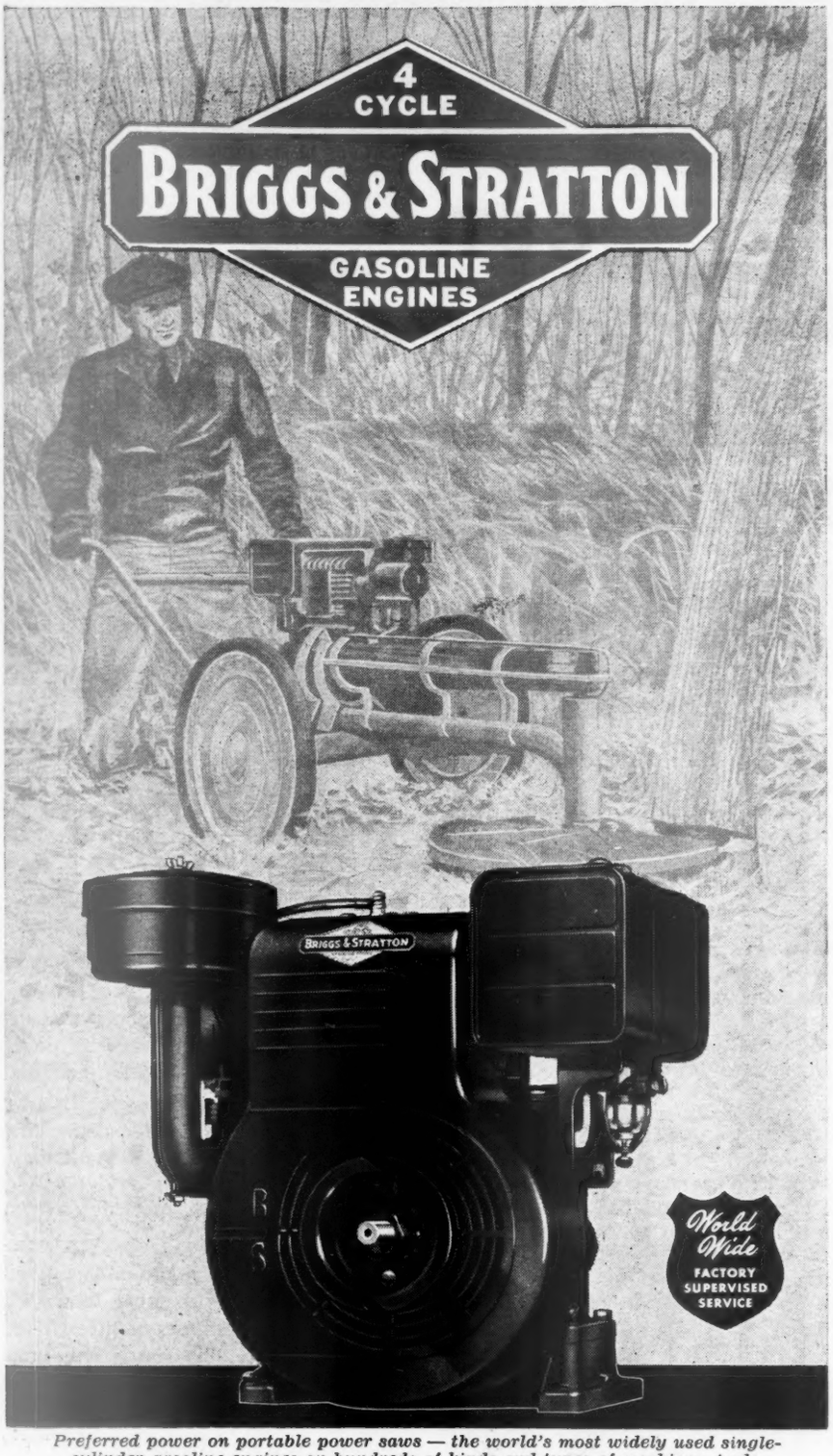

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Now to return to the question "What can we do about lost circulation?". Obviously, lost circulation can never be entirely eliminated, but by a well planned attempt to control the mechanical factors much may be done to reduce the severity and frequence.

You gentlemen control the vast majority of the rigs operating in the United States, and it certainly is within your power to reduce pressure surges that may be found to be causing loss in critical wells. Where trips are numerous, it might prove costly to you to increase the amount of time going in the hole, but if evidence can be supported proving new losses or rupture of old ones (as in the case of porosity coated with sealing materials) from rapid lowering of drill pipe, arrangements for suitable compensation could probably be made with the operator. Further, there seems to be no reason why circulating pumps cannot be opened slowly, or why the pumps should need to be kicked in before the kelly is lowered after having made a routine mouse hole connection.

There is one more suggestion that might ultimately prove beneficial to both the operator and the contractor, and which the author believes should merit careful consideration. This suggestion is that one of the most pressing needs of the drilling industry today is the formation of some sort of group to act as a clearing house in gathering and disseminating information relative to losses, their character, and the remedial procedures used, both successful and unsuccessful. For maximum benefit, these groups should function, primarily, on a sectional basis, where the nature of the losses and the curative techniques employed would be similar.

All too often, such factual data cannot be obtained because of a reluctance on the part of all concerned to release any information that might cause criticism of individual methods. It should be realized by all of you that seemingly incurable losses are not individual, but are happening to everyone engaged in the drilling industry.

There is no group better qualified to obtain such a wealth of information than the AAODC, and collectively, through the medium of your vast experience, you may be able to attain a goal that single-handedly you would find impossible to achieve, and that, gentlemen, is at least a partial reclamation of man-hours, rig time, and money currently being dissipated down the sewer of lost returns.

Acknowledgment

The author wishes to express appreciation to the management of Gulf Oil Corporation for permission to prepare and publish this paper; A. J. Teplitz of Gulf Research and Development Company; W. C. Goins, J. P. Weichert, J. L. Burba, Jr., and D. D. Dawson, Jr., of Gulf Oil Corporation, for valuable assistance rendered through the lost circulation panel of The Gulf Companies and the lost circulation study group of the Houston production division. ***

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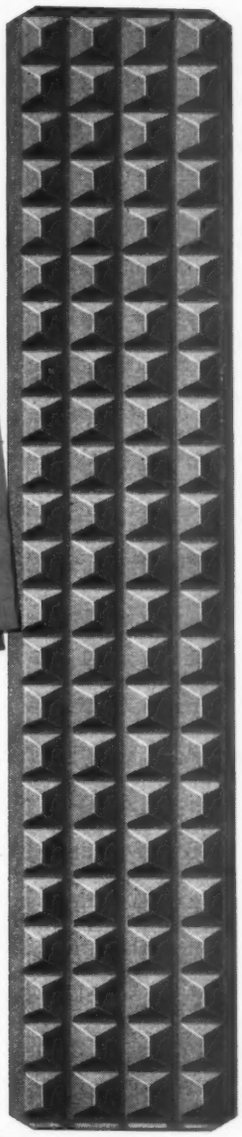

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Notes on the Well Spacing Problem

Another chapter in the growing literature on the producing and economic effects of spacing plans

C. W. TOMLINSON*

EVIDENCE that the spacing of oil wells may affect the quantity of oil recovered from an oil field was first assembled on a considerable scale and presented by Cutler in 1924. (See bibliography.) The essential facts observed by him have never been refuted. These are: When part of an oil pool, which is characterized primarily by solution-gas drive, is developed contemporaneously with another part of the same reservoir but with wells spaced farther apart, oil recovery by primary methods tends to be greater per well in the more widely spaced area than in the other, but less in total amount per acre, both in any given period of years and in ultimate total recovery.

That recovery *per well* is normally greater in the widely spaced area under these circumstances is conceded by all. It is in fact the primary economic advantage of wider spacing.

But the other fact reported by Cutler, the other face of the coin, was that the more widely spaced areas yielded less total recovery of oil per acre. This aspect of his findings has been interpreted by some as indicating that wide spacing in some areas leaves in the ground large quantities of oil that otherwise might have been recovered by primary methods, and that the total primary recovery from such pools of non-uniform well spacing would have been greater if all of their area had been drilled as closely as the most densely drilled areas. It also led to the conclusion that in some cases less total profit has been obtained than could have been realized from closer spacing of wells.[7]

Such inferences from this phase of Cutler's work have been vigorously contested. They cast doubt on the wisdom of wide spacing in many pools, where wide spacing was desired because of the larger profit thus to be obtained per dollar of development and equipment cost. On the other hand, since Cutler wrote, confirmatory evidence of greater recovery from closer spacing has been published from many other fields than those he cited[1]; and from separate pools of similar character but different spacing, as well as from areas of different spacing in the same pool.

It is generally admitted that irregularity of discontinuity of permeability in a reservoir may cause wells spaced unduly far apart to fail to recover oil that could have been obtained had wells been drilled at closer intervals. The importance of the "underground waste" so committed can be readily seen in some cases, where it can be shown that a reservoir of limited extent within the same area occupied by a larger pool at different level—a reservoir that has yielded many million barrels of oil—would have been missed altogether if wells had been spaced as far apart as in some other fields.[2] But the potential importance of this factor in a newly discovered field may be differently appraised by different people, within a wide range of possibilities. And it leaves untouched the possibility that recovery may be reduced by wide spacing even within a completely homogeneous and continuous reservoir.

Many students of reservoir flow have been inclined for some years to discredit the latter possibility entirely. But reexamination of the theoretical basis for that opinion discloses serious weaknesses in it. These are presented in a current paper by Tomlinson.[5]

Various arguments have been advanced in the attempt to disprove that closer spacing normally results in greater total recovery from a pool. Among these are the following:

Comparison Data

(1) The greater recovery per acre noted by Cutler from close-spaced areas in the same pool with areas of wider spacing is acknowledged, but is claimed to be due solely to drainage of oil from the area of sparser wells to that in which they were closer together. Such migration cannot take place between separate pools. Therefore, if such transfer of oil be the sole cause of greater recovery from closer spacing under otherwise identical conditions, there should not be materially less total recovery per acre from any pool with wide spacing throughout, than from a similar but separate pool with closer spacing. As greater recovery from close spacing is a matter of record in a number of such cases, effort has been made to discredit all such examples by ascribing the greater recovery to other causes, such as superior permeability; or by dismissing all comparison between separate pools as futile because no two are precisely alike in all respects. The latter position simply dodges the question. The association of closer spacing with greater recovery per acre-foot of pay remains a fact, and the claims of other causes to the credit for it must be weighed on their merits. It is worth noting that no examples have been published of substantially greater recovery from the more widely spaced of two closely similar pools, produced by the same methods.

In spite of the contention that no comparison between separate pools can be conclusive as to the effect of well spacing on recovery, because of differences in various respects between each pool and every other, an extensive attempt was made by the Committee on Well Spacing of the American Petroleum Institute to do just that. By graphic methods, they reached the conclusion that no such effect was evident[2]. But statistical analysis of the same data, and even of the same graphs, indicates that they supply instead, if the present author has correctly interpreted them, a striking substantiation of the extension of Cutler's principle to comparisons of recovery from separate reservoirs differently spaced—even for fields with effective water drive. This evidence is presented in another current paper by Tomlinson[6].

In one way, selection of the optimum spacing of wells for any single reservoir is less difficult than the problems involved in comparing recoveries from one pool with those from another. For in the single pool, the question is simply what effect different spacings might have on recovery or profit, under *the same* set of reservoir conditions. No factor differs except spacing. And yet the basis for any such decision must be past experience in older fields of similar type, and theory based upon such experience. If spacing has no effect whatever on ultimate total recovery from the pool, wider spacing will be desirable in most cases than if such spacing is a definite handicap to maximum recovery. In either case, however, the time re-

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EXCLUSIVE

quired for adequate drainage of the reservoir is a pertinent factor in the problem.

The minimum average time necessary for movement of oil through various distances in radial flow to wells in a porous reservoir can be ascertained directly from the velocity of inflow into the wall of a well. Preliminary study of this problem indicates that movement of oil through the long distances necessary to explain *all* of the greater recovery of oil from the more densely drilled areas of some fields by movement from their wider-spaced areas would require far longer time than has actually elapsed[5]. It also demonstrates that the time required to drain 40 acres to one well at actual rates of production is longer than the commercial life of most wells. Therefore much of the credit for the admittedly superior recovery of such densely drilled areas must be ascribed to more nearly complete recovery of the oil from within those areas, rather than the import of oil from the more widely spaced areas of the same field.

Drainage of oil from wide to close-spaced areas doubtless has contributed to excess recovery from marginal areas more densely drilled than adjacent tracts. But in view of the varying relative areas of wide and close spacing in the many fields in which Cutler's rule has been found to hold true, it is difficult to see how such drainage alone could account for the consistent relationship actually found between spacing and recovery; even if sufficient time had elapsed to accomplish the long-distance movement required in some cases.

Friction Factor

(2) It is claimed that Cutler's suggestion was in error, as to the cause of greater recovery from closely drilled areas that lie in the same pool with more widely spaced tracts. His suggestion was that the greater recovery from close spacing might be due to the fact that a greater quantity of energy is required to overcome friction in flow of a unit of liquid through a longer distance in a porous reservoir. There is no reason to suppose that any consistent difference exists in such cases in the natural endowment of energy per acre, between sparsely and densely drilled areas. Therefore, if use of energy in flow were porportional to distance, primary recovery should be inversely proportional to distance between wells: unless the natural supply of energy is greater than that needed to bring all recoverable oil to the wells on the widest spacing involved. This is the very relationship between spacing and recovery that actually was found by Cutler in the recovery records he assembled, and which has been found since then to exist in other fields also.

It has been claimed that in radial flow energy required is not proportional to distance traveled: That it is much less per unit of distance for longer distances, because of the slower flow at greater distance from a well. It has been

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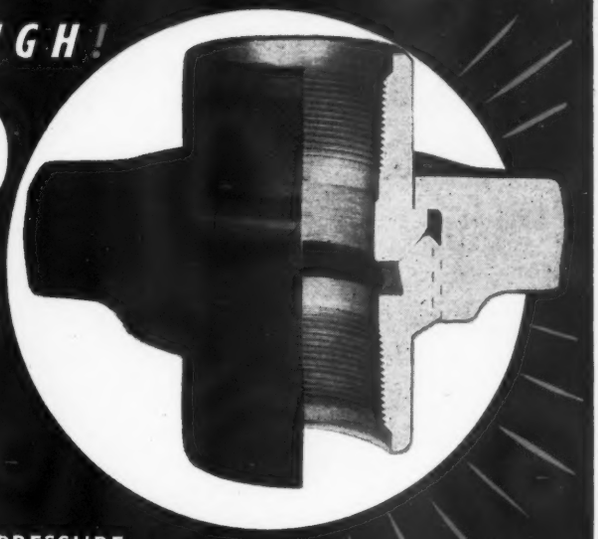

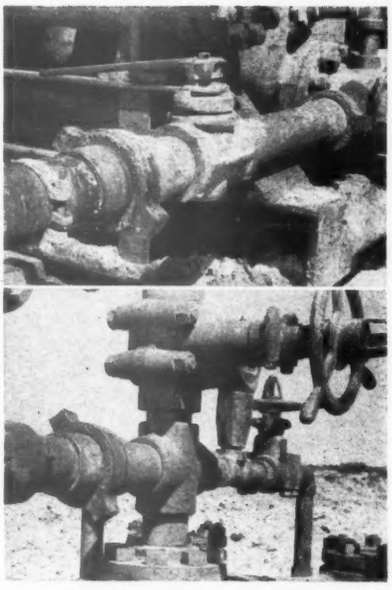

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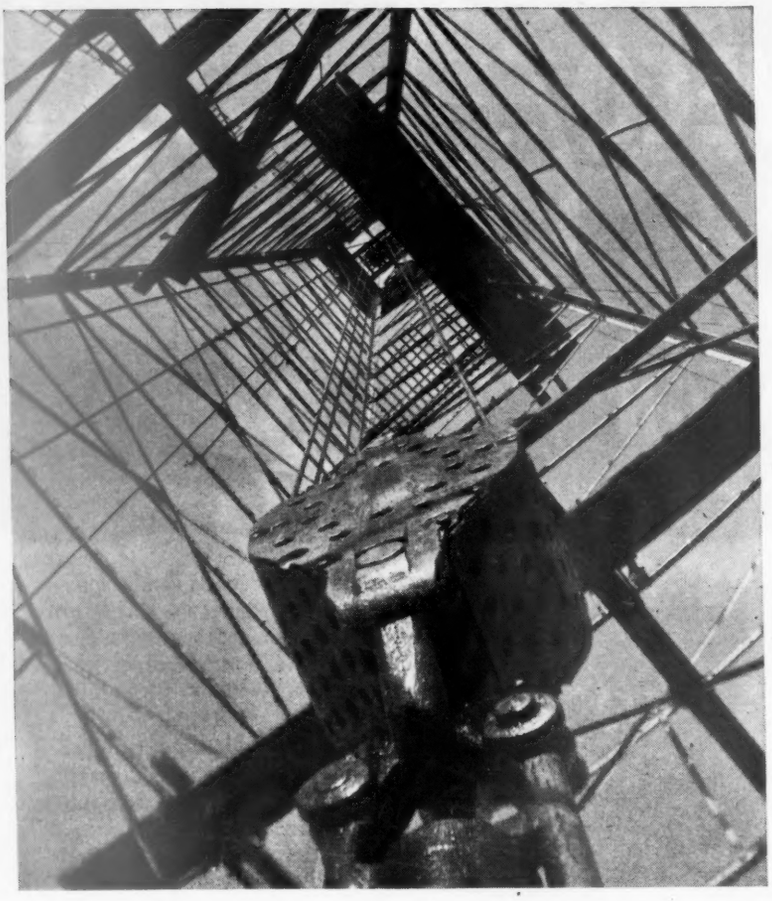

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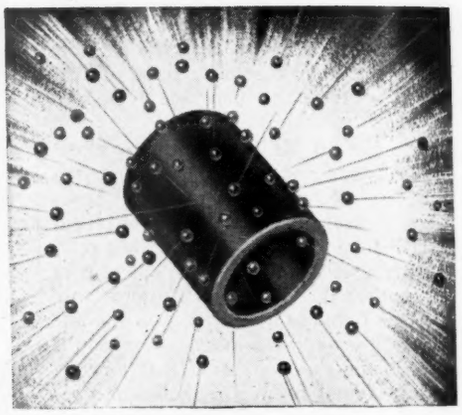

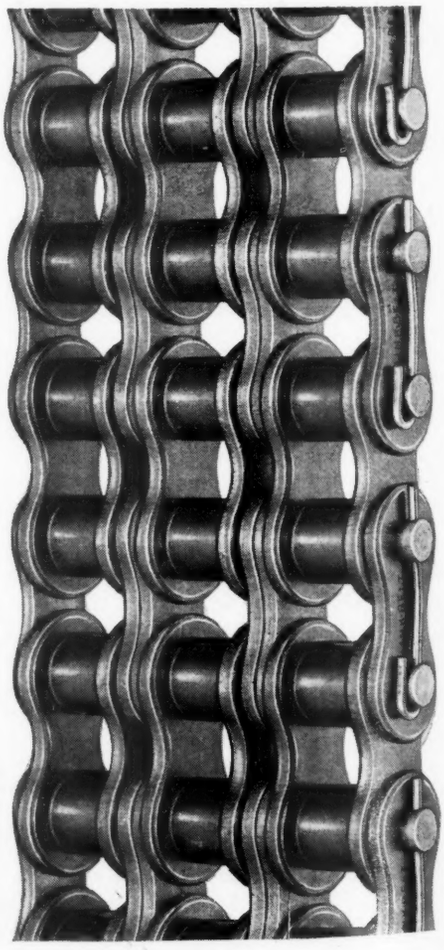

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demonstrated mathematically that this is true for steady flow of uniform liquid through homogeneous reservoirs of identical character, *at equal rates of delivery* to wells of unequal drainage area. (Miller and Higgins, 1939.)

But equal rates of delivery were not what Cutler found. Greater rates of yield (per well) by more widely spaced wells are universally conceded in unrestricted primary production; and are no less certain in production against equal back pressures.

Cutler found that rates of yield (and of total recovery) per well for different well spacings in the same pool tend to be proportional to distance between wells.

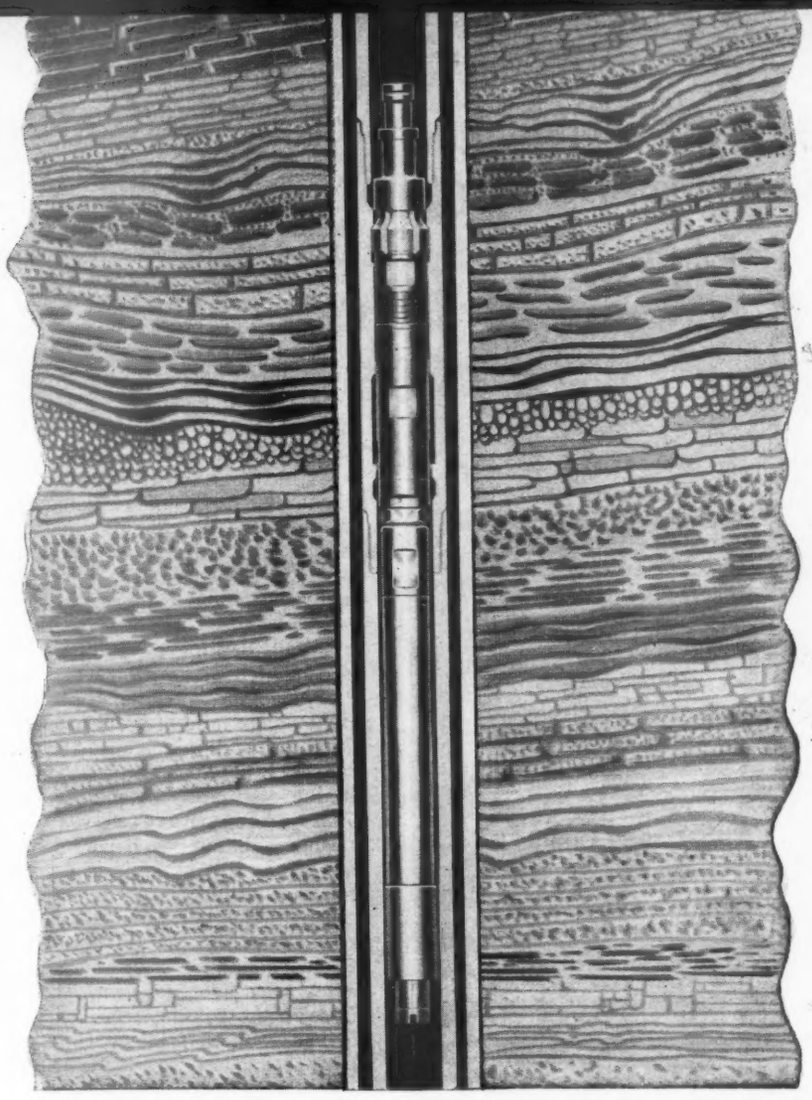
When this factor is introduced into the Miller and Higgins equations for energy used in steady radial flow of uniform liquid, the mean total energy required to bring a barrel of oil to a well is multiplied in direct proportion to rate of yield, and to distance between wells. Under these circumstances, Cutler's concept that mean energy used per barrel of liquid delivered in radial flow is proportional to distance traveled holds precisely true as between large and small drainage areas; except for a correction (10 or 12 per cent for ordinary well-spacings and well-diameters) for differing ratios of well-diameter to drainage radius. And for equal well-diameters, that correction is a further handicap to wide spacing—a further reduction in the relative quantity of energy required in flow to close-spaced wells.

Where both well-diameter and production (of uniform liquid) per well per day vary in proportion to distance between wells, other things being equal, mean velocity in steady flow is the same in the drainage area of every well in a homogeneous reservoir, regardless of spacing. And for equal mean velocities, energy required in radial flow is proportional to distance traveled, just as truly as in linear flow at constant velocity.

Cutler's great contribution was the discovery of a simple and now widely admitted fact: In an important number of cases, recovery per acre tends to be in inverse ratio to distance between wells. There is a remarkable coincidence between this fact and the quantity of energy required, on the average, per barrel of oil produced under different spacings, to bring oil to the wells. The total energy required per acre per day in flow, under the factual conditions described by Cutler, varies little between areas of different spacing. It would be identical, other things being equal, if well-diameters differed in the same ratio as distance between wells. This is precisely what it should be if the natural endowment of energy available to produce flow were equally distributed throughout the reservoir. This coincidence is too impressive to be ignored.

Available Energy

(3) It is claimed that all discussion



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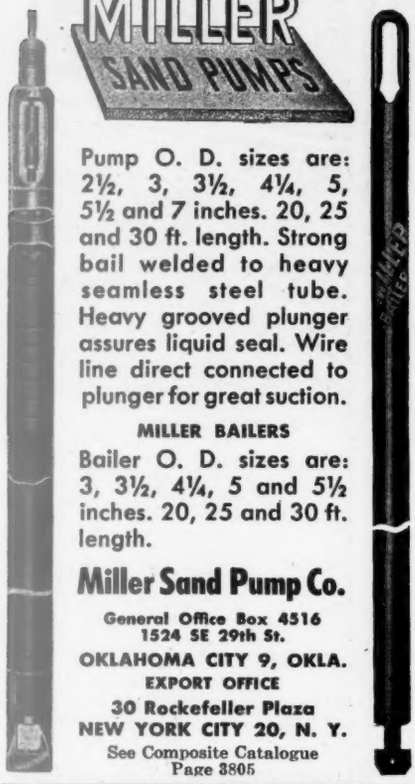

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of the effect of well spacing on energy required in flow is academic anyway, because the energy naturally available in most reservoirs is far greater than the quantity needed to bring all recoverable oil to the wells, no matter how widely they are spaced. This seems most plausible for pools with active water drive, but is claimed also for pools in which only solution-gas drive is regarded as important in primary recovery.

This claim brushes aside as due to waste of gas the obvious fact that primary methods recovered from many old fields but a minor fraction of the free oil therein. At the time of abandonment of wells in those fields the reservoir energy still available was certainly unequal to the task of maintaining a profitable rate of flow to those wells. Almost every secondary recovery method (except infill drilling or mining) involves the injection of added energy into the reservoir. This is true also of "pressure maintenance" and of every procedure by which gas or liquid is injected into the reservoir, whether applied at the beginning of production or only later.

The energy naturally available through solution-gas drive to produce flow in any oil reservoir is released by reduction of pressure at wells. When such reduction takes place, liquids must expand. If they contain dissolved gas, sufficient reduction of pressure normally causes release of gas, with drastic increase in the volume occupied thereby. Further reduction in pressure as the gas approaches a well brings about additional expansion of its volume.

If there is not enough reservoir energy for *all* requirements during the commercial life of the wells, the proportion of recoverable liquid brought to the wells will be reduced. That it has been a regrettably low proportion in some cases is a matter of record. To what extent it could have been improved by control of gas-oil ratios (without injection of gas or liquid into the reservoir) is open to question.

Retardation of flow is not *of itself* a means of conserving reservoir energy. It reduces the energy used to overcome friction in flow to the well, but the energy so saved is expended in overcoming the artificial resistance (usually a choke) by which flow is restricted. Under such circumstances, furthermore, part of the dissolved gas that otherwise would have been freed in the reservoir is not released until after passage through the choke; and its release then accomplishes nothing in propulsion of oil through the reservoir. Similarly, the gas previously released does not complete its expansion until it has passed the choke. Any net saving of energy due to restriction of yield must be due to incidental effects on the character of the fluid remaining in the reservoir.

In active water drive, energy expended within a reservoir that was occupied by oil at the beginning of production is continually replenished in some degree by the incursion of water into that space. In infinite time, under truly artesian conditions, unlimited energy might be so supplied. But it cannot be supplied at an infinite rate. The amount that can be brought into the reservoir in a given period of time is a limited quantity. And in water drive, there is an entirely separate factor—coning—which if effective at all must favor improved recovery from closer spacing of wells, other things being equal. Coning may remain an important factor even at extremely slow rates of recovery. On the other hand, certain water-drive fields that were produced without restraint, but densely drilled, achieved enviable recoveries per acre-foot of pay. Whether through conservation of energy or through multiplicity of cones, the density of drilling surely played a part in that success. Evidence that it has had similar effects in many other water-drive fields is presented in one of the papers above cited[6].

That natural reservoir energy available to produce flow, if properly conserved, is in all cases much greater than the amount required for medium recovery, is an obvious overstatement. For the amount required approaches infinity as permeability approaches zero, and increases directly with viscosity. Other things being equal, ten thousand times more energy would be required on a given spacing for adequate recovery of oil of 100 cp. viscosity from a reservoir of 10 md. permeability, than for oil of 1 cp. viscosity in a reservoir blessed with 1000 md. permeability. All those figures are well within the range encountered in commercial oil fields. Good recoveries of very viscous oils have been achieved only in very permeable reservoirs. The A. P. I. Committee on Well Spacing found clear evidence that both high viscosity and low permeability are handicaps to ultimate recovery[2], even in water drive fields. Why, if available energy is unlimited?

Cutler's Rule

(4) Cutler summarized his findings in the following tentative statement, which has come to be known as Cutler's Rule: "The ultimate production for wells of equal size in the same pool, where there is interference (shown by a difference in the production decline curves for different spacing), seem approximately to vary directly as the square roots of the areas drained by the wells." He added the following comment: "From this rule it follows that where interference exists between wells, doubling the distance between wells doubles the ultimate production per well and halves the ultimate recovery per acre."[3]

This has been ridiculed on the ground that it becomes absurd when extrapolated to infinity: As the square root of infinity is infinity, the rule as stated can be stretched to imply that an infinite number of wells should secure an infinite quantity of oil from any reservoir —that recovery can be increased without limit by increasing the number of wells. This criticism is not justified, for an infinite number of wells in a finite reservoir is no more possible than in-

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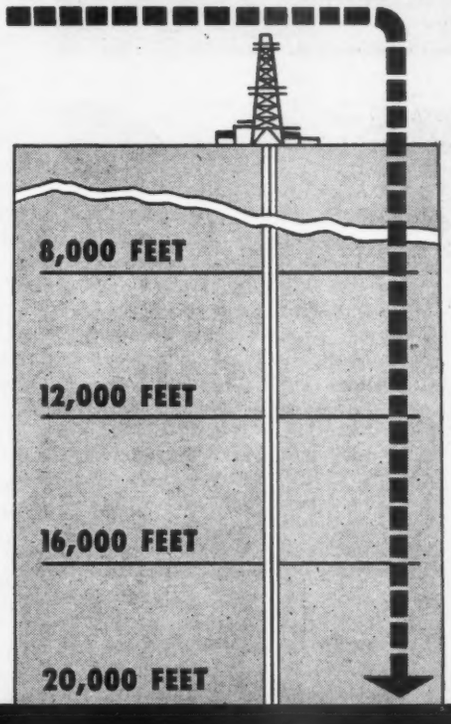

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finite recovery of oil from it. The most obvious limit to the applicability of Cutler's Rule is the number of wells that would completely drill up the reservoir and mine all the reservoir rock. But for all oils that will flow at all and all reservoirs that will let them do so, there is a limit short of that. If any natural energy whatever is available in the reservoir to produce flow, it is adequate to bring all recoverable oil *some* average distance to the wells. Spacing that will just permit maximum recovery by primary methods is defined as the *critical spacing* for that pool.[5] Denser drilling would result in no appreciable addition to recovery. But wider spacing would yield smaller total recovery from the reservoir by primary methods.

For sands as permeable as the best of Kuwait or Lake Maracaibo, with oils of low or moderate viscosity under substantial initial pressure and reasonably well saturated with gas, critical spacing may be very wide indeed, even without water drive. For oils of high viscosity in rock of low permeability at shallow depth, it may be very close. For a new field, critical spacing can be determined only from past experience in similar fields. But if these concepts are correct, its study should be regarded as a problem of importance relative to each new discovery.

And such study cannot wisely be left until after a pool has produced for some years. It is sometimes urged that very wide spacing be followed in the early development of every field, as infill wells can be drilled later if found advisable. But in the interim, unless the originally chosen pattern is closer than critical spacing, reservoir energy will have been expended in greater quantity per barrel of oil recovered, than would have been the case with closer spacing. Against the same back pressures, the liquid produced will have moved faster near the wells; and a greater quantity of liquid (relative to that produced) will have been in motion in the reservoir, flowing toward each well.

Rate of Inflow

(5) The inevitably greater rate of inflow to more widely spaced wells upsets the mathematical proofs heretofore published, which seemed to demonstrate that little more energy is required to drain a large area than a small area to a single well. This fact is immaterial, of course, if energy available to produce flow is in all cases ample. (See heading (3), above) It is also set aside by some on the ground that the evidence presented under heading (2), above, deals only with steady single-phase flow—flow of an unchanging uniform liquid; whereas actual reservoir conditions nearly always include diminishing rate of flow and some liberation of gas from solution in oil, and therefore the movement of gas as well as of oil; and in most cases involve the presence of water also.

If the discussion presented here can be set aside as irrelevant for that reason, so must all previous mathematical studies of steady radial flow of uniform liquid to wells—including those that seemed to disprove Cutler's suggested explanation of his rule. On the other hand, it is difficult to see how the laws of single-phase flow can be irrelevant to those governing the more complex conditions that are present in multiple-phase flow—indeed, how the former can fail to be basic to the latter. The essential task is the same in both cases: To move oil to the wells.

Gas Waste

(6) In connection with pools in which solution-gas drive plays a large part, it is claimed that conservation of gas rather than of energy is the vital thing, and that close spacing is apt to mean waste of gas. But the same gas-oil ratios can be applied to many wells as to a few. The total amount of gas liberated from a unit of oil during a given reduction of pressure on that unit will be the same no matter what the spacing. Regulation to the minimum practicable gas-oil ratios is designed to assure maximum usefulness of the gas in assisting movement of oil to wells, as well as to minimize waste of gas through lack of market for it. The goal is to attain maximum production of oil for each unit of gas released. Other things being equal, the all-important task of moving oil to the wells is less, the shorter the distance the oil must move, and the more slowly it moves. But gas released after oil reaches a well, or its further expansion thereafter, can accomplish nothing in the reservoir.

In short, each of the major premises on which Cutler's rule has been attacked is itself vulnerable. In spite of the wide acceptance in recent years of the thesis that well spacing makes no substantial difference in total recovery of oil from a reservoir, it is hoped that presentation of such vulnerable points may cause some restudy of the matter.

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* * *

Over half of the 10,000 to 12,000 geologists in the United States are engaged in the continuous search for new deposits of petroleum.

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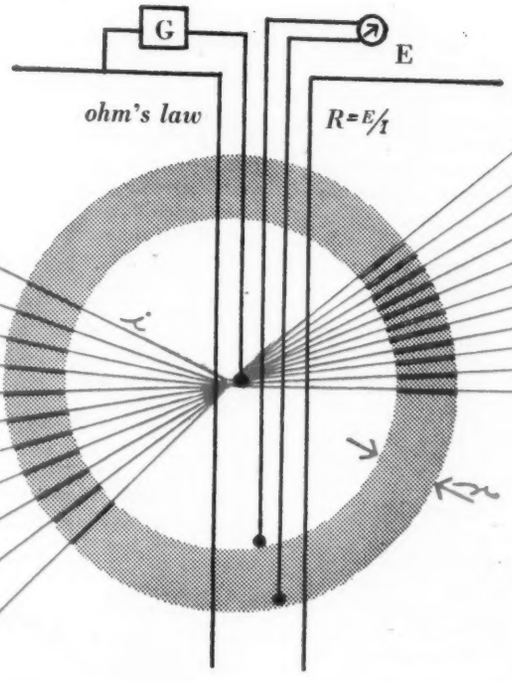

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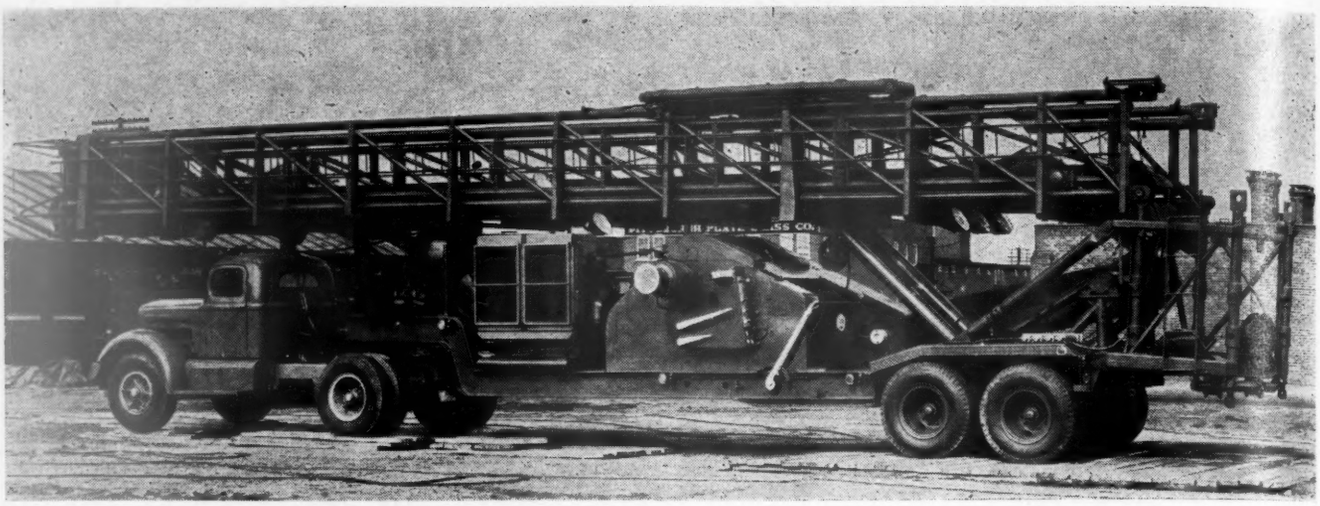


Complete with drawworks and its own portable mast, this trailer-mounted drilling rig can be transported quickly from place to place. Width is held at 8 ft, to comply with legal maximum of most areas.

Drilling Equipment Design

PROBLEMS of designing drilling equipment, to combine ruggedness and dependability, satisfactory performance, appearance, size, and low cost were described to the Rocky Mountain Chapter, American Association of Oil Well Drilling Contractors at Casper, Wyoming. The speaker, H. E. Heywood, Jr., assistant chief engineer of the Toledo, Ohio, plant of The National Supply Company, pointed out that design represented a series of compromises.

For instance, it is desirable to make the drum spool large in diameter and of maximum length so that the wire line will build up to as few layers as possible when hoisting. But diameter of the drum spool must be kept within reasonable limits to avoid the need for applying too much torque through the drum shaft. Increase in torque, of course, requires heavier chain, clutches, shafting, etc., which in turn increase the cost and weight of the drawworks. Also, for transportation reasons, it is desirable to restrict the width of the drawworks to 8 ft. This puts certain practical limits on the length of the spool.

The need for portability of small drilling rigs adds to the designer's problem, he said. Used for rotary drilling of wells less than 5000 ft deep, these rigs complete a job in a few days and must then be moved to some other location.

Trucks are available that can move a small rig in one piece, but the question of legal load limits must be borne in mind. Because the legal width is almost universally set at 8 ft, many rigs are designed so that the main frame is limited to this width, and equipment extending beyond 8 ft can be demounted during travel.

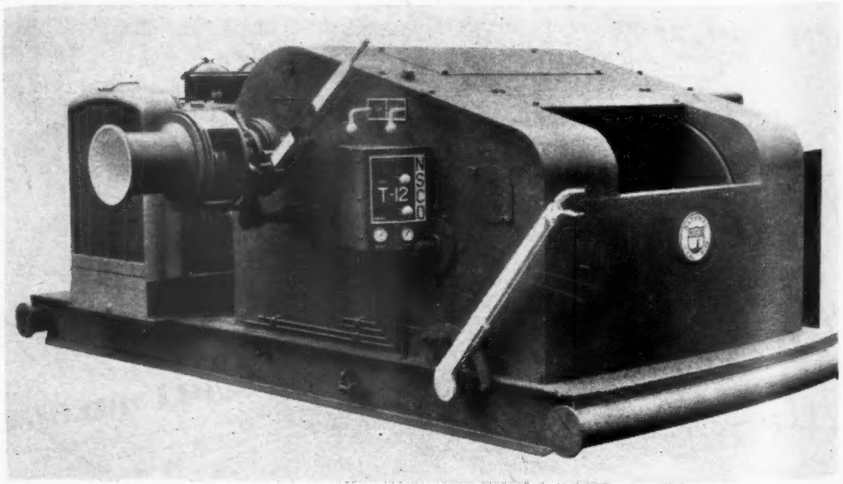
Truck-mounted and trailer-mounted rigs, complete with portable masts, were among recent developments described. The speaker predicted that today's rotary drilling method would not be superseded for many years, but that machinery details would be improved.

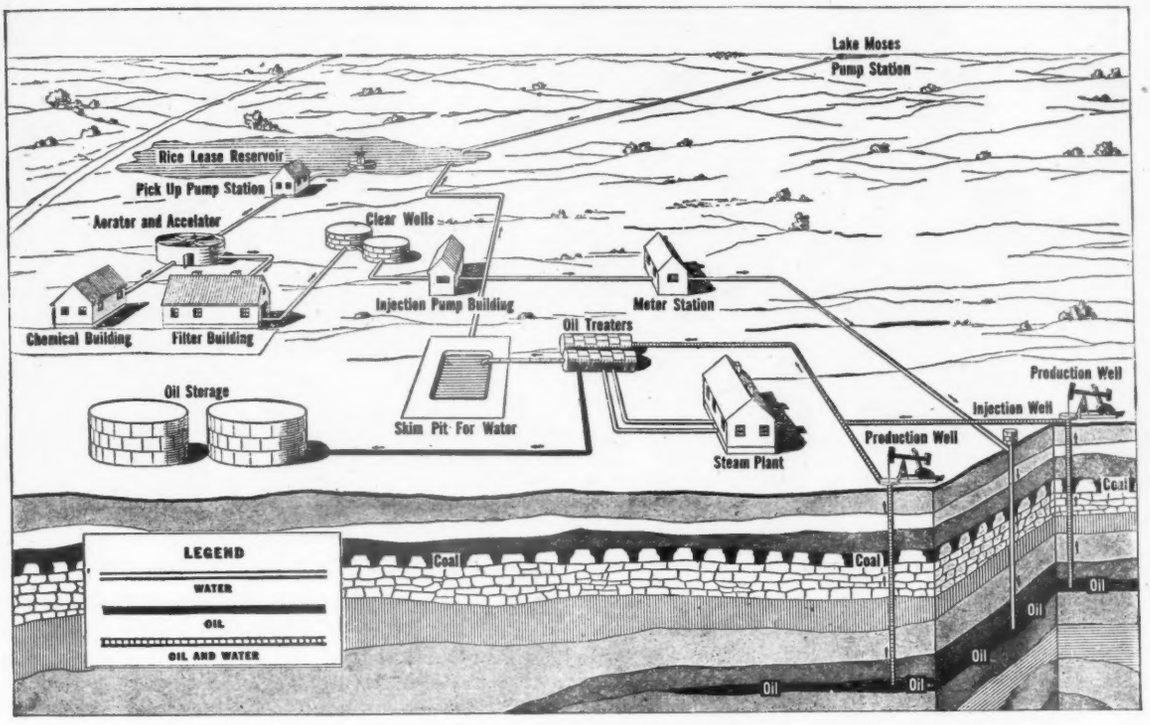
The fluid torque converter, now in its infancy in this field, will improve in performance and application because it is ideally suited for the intermittent hoisting of a drilling rig, he said.

When the load is first begun in motion, the converter puts out high torque to overcome the inertia and get the load in motion. It then continues to put out the amount of torque required to keep the load moving steadily, and converts the rest of the power into speed.

Because of the infinite ratios of the converter, two ratios in the drawworks are usually sufficient. But these should be chosen so that the converter is operating in its high efficiency range when the desirable range of hook or hoisting speeds is being produced. The lower ratio must be proportioned to give the maximum pulls desired. * * *

Typical small rig, rated at 120 hp, is used for 1500 to 300-ft drilling; has fluid torque converter and provides two drawworks speed ratios to the drum and rotary.





To replace depleted underground pressure in the Benton (Illinois) oil field Shell Oil Company, operating the project on behalf of all operators in the field, is daily pumping about 1,250,000 gal of chemically-treated water into the oil bearing sands more than 2000 ft below the surface.

Water Flood Produces Million Barrels Oil

New life for old oil fields is promised by the success of a conservation project demonstrated recently in Benton, Illinois. Called the Benton Water Flood, the project consists in pumping water down into oil-bearing formations and thus forcing to the surface millions of barrels of oil that would not otherwise be recovered. The flood was planned and is being operated by Shell Oil Company.

According to W. A. Alexander, Shell vice president, the Benton flood "points to greatly increased production from other old and lagging fields in the mid-continent area. Tremendous quantities of oil remain in these fields," he said, "but natural pressure has fallen so far that very little oil can be recovered economically by ordinary methods. Water flooding, such as that used at Benton, may well solve the problem."

Less than two years after beginning water injection, the Benton Water Flood had produced 1,000,000 bbl of oil more than would have been recovered from the field if the flooding method had not been used. Production, which had fallen to a few hundred barrels a day before the flood, is now 7500 bbl a day. Millions of barrels more are expected to be taken from the field before the flood is completed.

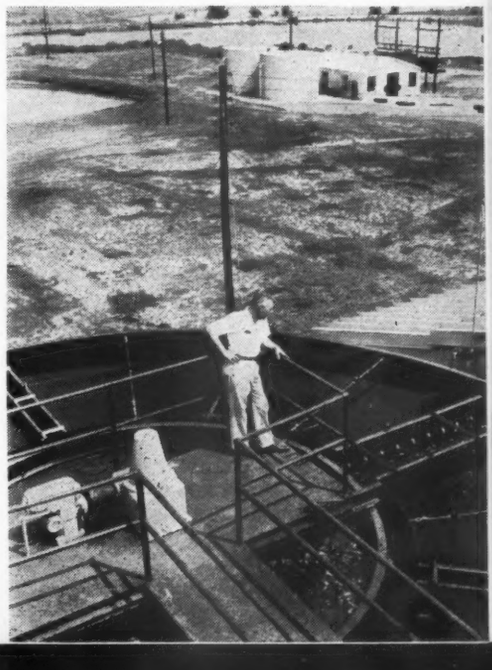
The Benton operation is especially remarkable because the oil-bearing sands lie about 1400 ft below a large coal mine. Some oil wells run down through the supporting pillars of coal. Special casings had to be put into such wells before they could be used for injecting water into the oil sands.

The installations needed for the flooding operation include a reservoir, water-treating plant, and an elaborate system of pumps and pipes. Water is piped to the reservoir from a lake six miles away. The treating plant removes contamination that might plug the oil sands and so block the flood. As water is pumped into the field it fills the space left by oil and gas already produced and pushes remaining oil to the wells and up to the surface.

Alexander explained that for a water flooding operation to be practical, the entire oil field must be operated as a single unit. At Benton, this required the agreement of 275 interested parties. When this had been obtained, Shell converted certain of the field's wells from oil production to water injection, installed the needed equipment, and proceeded with the flood. Each owner receives a share of the newly increased production based on his share of the field's total production before the flood began.

* * *

Plant where water that is to be injected into oil bearing sands is purified and chemically treated.



AAODC 1952 officers are: Earle C. Flesher, Johnson and Flesher Drilling, vice president, Central Mid-Continent; Joseph V. Dunbar, Dunbar Drilling, vice president at large; A. W. Thompson, Thompson-Carr, president; Brad Mills, AAODC, executive vice president; Marion S. Church, general counsel; Louis A. Beecherl, McDaniel and Beecherl, treasurer. Standing are vice presidents, A. H. Bell, Bell and Burden, California and well servicing; E. K. Carey, Carey Drilling, Rocky Mountains; J. U. Teague, Columbia Drilling, Gulf Coast; N. H. Wheless, Jr., Wheless Drilling, cretaceous and tertiary basin; Harold M. McClure, McClure Drilling, cable tools; R. S. Makin, Makin Drilling, West Texas and New Mexico, and J. Doyle Settle, AAODC, secretary. Not shown is Thomas S. Doran, Vandalia, Illinois, who has been elected AAODC vice president for Illinois, Michigan, Indiana, and Kentucky.

AAODC Holds Eleventh Annual Meeting

The American Association of Oilwell Drilling Contractors held its 11th annual meeting in Fort Worth, Texas, recently. F. W. Brigance, Rowan Drilling Company, was in charge of general arrangements. The two-day meeting was filled with committee meetings, general sessions, and board of directors meetings, which were held in the Hotel Texas.

AAODC accounting committee, left: C. H. Todd, Rine, chairman; D. C. Anderson, Rowan; F. E. Godfrey, Big Chief; W. R. Ewert, Kerr-McGee; C. H. Phifer, L. D. Cain, vice chairman; John Campbell, Thompson-Carr; William Burrough, Kemp; O. Lee Wood, Westlund; Jack Bowden, Glasscock; Carl W. Sebits, Pickrell; James W. Brown, Westlund.

Insurance group, right: Marion S. Church; Howard E. Oexman, Delta; E. Dale Mount, vice chairman, and R. D. Jocoy, Harry Bass Drilling; Helen Chatham, Mid-Continent Supply, secretary; B. A. Wales, J & C Drilling; J. D. Settle; W. E. Armentrout, Southeastern; P. H. Van Wagoner and J. W. Walker, Rig Insurance, and K. B. Knox, Knox Drilling.

At left, are W. L. McClusky, M. J. Delaney; C. F. Whaley, Chet Whaley Well Servicing; James G. Adkins, Adkins Drilling; W. W. Cline, San Joaquin Drilling, and L. L. Payne, Hughes.

Enjoying the Hughes Tool breakfast, below, are Mrs. A. W. Thompson; Mrs. H. C. Fitzpatrick; W. S. Fitzpatrick, Fitzpatrick Drilling; Mrs. W. S. Fitzpatrick; Roscoe Ayres, Bovaird Supply Company; H. C. Fitzpatrick, Fitzpatrick Drilling; Mrs. Gregg E. Sawyer; Gregg E. Sawyer, Sawyer Drilling; A. W. Thompson, AAODC president, Thompson-Carr, Inc.

Above—The AAODC harmony quartet consisted of: T. C. Hughes, Link Belt; M. M. Brantly, Drilling and Exploration; C. P. Jenkins, National Supply, and Jerrold Drexel, Web Wilson Oil Tools.

A banquet was held on the last evening of the meeting at the Hotel Texas. P. C. Spencer, president, Sinclair Oil Corporation, New York City, spoke on "Contribution of Contractors toward Oil Needs of Tomorrow." Webb Maddox was toastmaster.

NEWS

Follis Says Salt Lake Area May Be Crude Oil Source

The Salt Lake area may develop into a major source of crude oil for the Western states, but this is not yet a certainty at the present time. Much exploratory work remains to be done, and many difficult problems solved.

This was the appraisal expressed by R. G. Follis, chairman of the board of Standard Oil Company of California. Follis, in Salt Lake City for a meeting of his company's board of directors, spoke at a local press conference of the exploration work his company is doing.

He said:

"Standard Oil Company of California and its subsidiaries are currently exploring on all sides of Salt Lake in Utah, and also in Western Colorado, Southwestern Wyoming, Southern Idaho and Eastern Nevada. Of these areas, the Uinta Basin looks most promising at this time, and may develop into a major source of crude oil for the Western states. However, the success of this area seems right now to be indeterminate. Some of the conditions there make it seem doubtful. On the other hand, it could become one of the nation's large petroleum reserves."

He stated that three oil wells and one gas well have already been completed by The California Company in the Red Wash field, where, Follis said, present oil production is about 450 bbl a day. He added that five drilling rigs are now being used by the Standard subsidiary to further examine the lands surrounding the Red Wash discovery. In addition, the company is operating four rigs on other wildcat projects in the Rocky Mountain area.

Saudi Arabian Output

Crude oil production in Saudi Arabia during September amounted to 25,412,024 bbl, or an average of 847,067 bbl per calendar day, it was announced by the Arabian American Oil Company. This compared with the 25,971,707 bbl produced in August, an average of 837,797 bbl per calendar day.

Crude oil production for the first nine months of 1951 amounted to 198,303,535 bbl, an average of 726,387 bbl per calendar day.

Stanford Oil Opens New York Offices

Stanford Oil Company, Chicago, Illinois, has announced the opening of New York offices in the Empire State Building, 350 Fifth Avenue. Space on the 73rd floor will be occupied by a small staff. The company, which is an oil producing company engaged in drilling in the tri-states oil area in Illinois, Indiana, and Kentucky, has headquarters in the Board of Trade Building, Chicago, and an office in Evansville, Indiana, for the geology, land, and production departments. It is headed by Kenneth J. Stanford.

Twaits Reports on Imperial in Canada

Speaking before the Montreal Kiwanis Club, Montreal, Canada, W. O. Twaits, director, Imperial Oil Ltd., reported that on the basis of discoveries in Alberta from 1947 to 1950, inclusive, the ratio is one successful commercial wildcat well for every 23 drilled. He added that it was after 133 dry holes that Imperial discovered crude oil at Leduc.

Twaits added, "Oil reservoirs are by no means regular in outline and the outline may take some years to determine. The Leduc field, for example, has an outline vaguely similar to that of a ballet dancer standing on one toe with one arm raised above her head."

"Now I don't wish to imply that ballet dancers are irregular in outline! But if you had to throw darts at one in a typical ballet stance from a distance of about a mile above her, you would be surprised how easy it is to miss!"

Harrison Offices Set Up

Robert W. Harrison, formerly associated with the R. B. Mitchell Company, has announced the opening of offices of Robert W. Harrison and Company, consulting petroleum engineers and geologists. Address is 504 City National Bank Building, Houston, Texas.

Canadian Offices Moved

Socony Vacuum Exploration Company has announced that all offices have been moved to the Barron Building, Calgary, Alberta, Canada. New telephone number is 66281.

Exploration Firm Sets Up Louisiana Headquarters

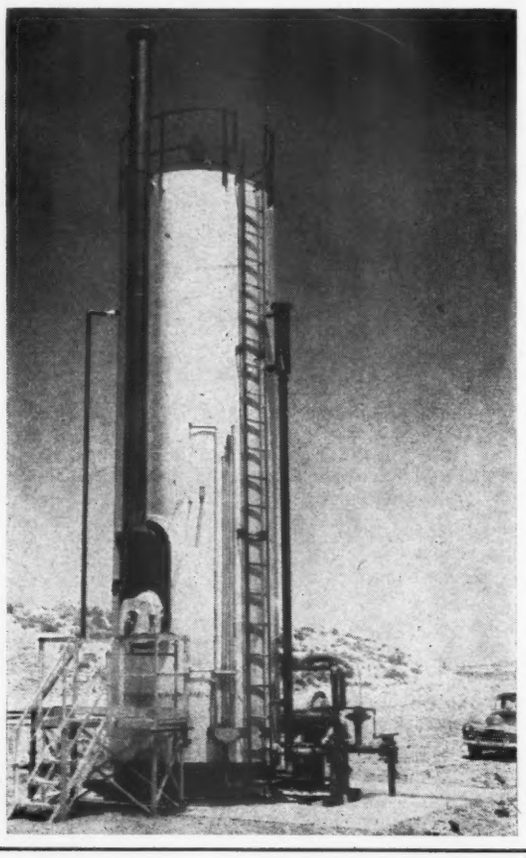
The Louisiana Exploration Company has set up headquarters at New Iberia, Louisiana. B. H. Treybig, Jr., will be manager of the new company, which he formed. A Rice Institute graduate, Treybig saw service with The Texas Company until he resigned to form the company. The firm specializes in salt dome and fault problems common to Gulf Coast geophysics.

ASME Studies New Drill

The American Society of Mechanical Engineers' petroleum division has announced that percussion drills used in mining and quarrying are under study as a better and cheaper way to drill for oil. The drill, which strikes from 300 to 900 sharp blows per minute would batter its way through rock formations. It combines the principles of the old cable tool, which was lifted and dropped against the bottom of the hole, and today's rotary tool, which grinds its way through rock.

Article Describes Research Institute

Reprints of a comprehensive description of research and development facilities and services at Midwest Research Institute, Kansas City, Missouri, are now available. The article carried pictures, a long list of specialized labs, and some representative completed programs, among them ore identification, mineral assays, lightweight, aggregate studies, and resources surveys.



National Tank Oil Treaters

In line with the growth of the oil industry in Alberta and adjoining provinces, the National Tank Company some time ago made an agreement with the Dominion Bridge Company, whereby the latter were accorded the right to manufacture National Tank Company oil treaters in the plant of their Edmonton subsidiary: The Standard Iron and Engineering Works, Ltd.

Edmonton being the center of the oil fields was deemed to be an excellent place to undertake this manufacture and more than sixty treaters of various sizes have already been fabricated or are in course of manufacture. The accompanying photograph shows an oil treater in service.

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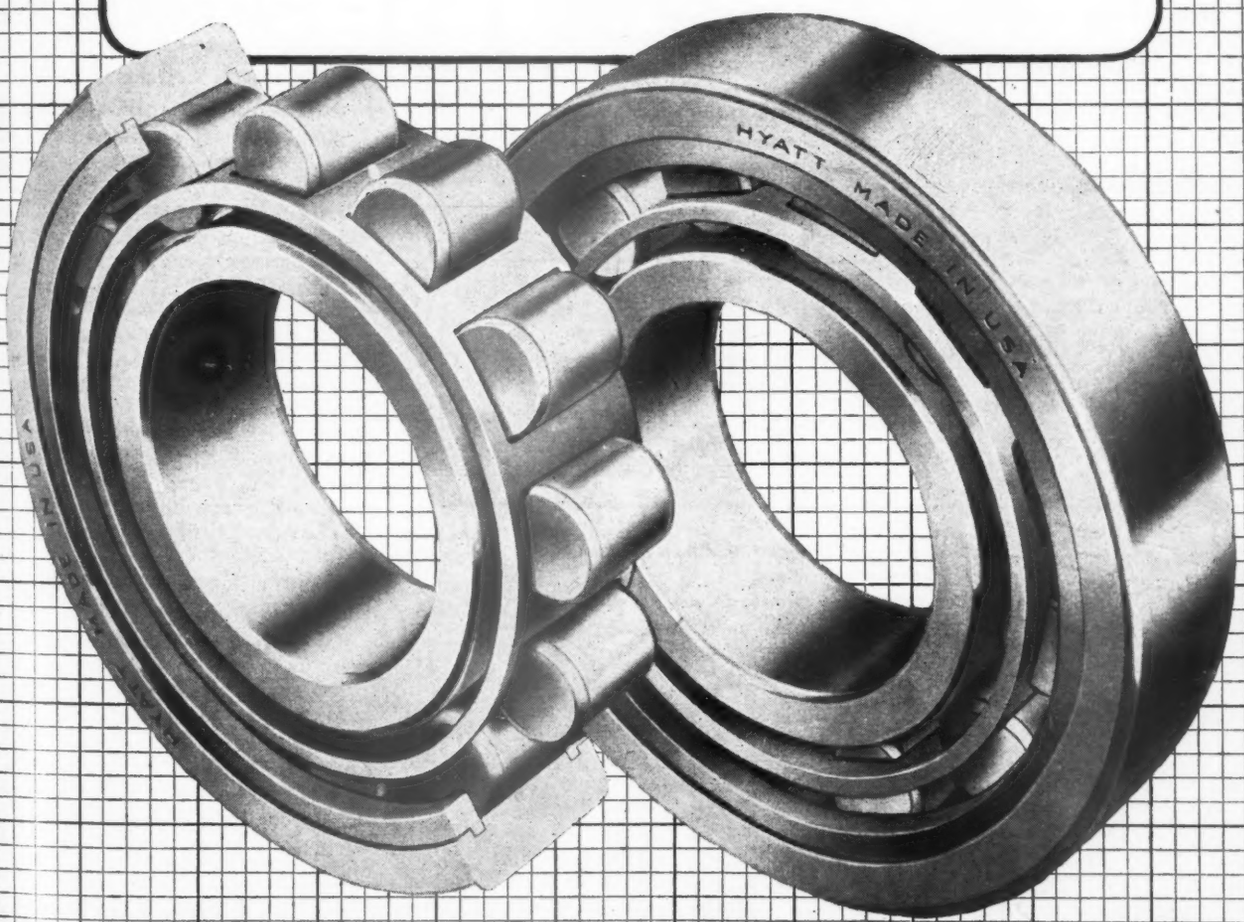
Throughout the field, machines produced by leading manufacturers are Hyatt-equipped and have been for many years. The dependable performance of Hyatts is in no small way due to the precision and the year-after-year durability built into them. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

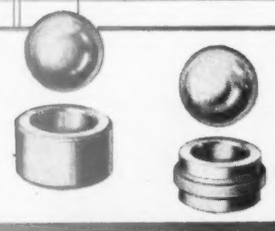


HYATT ROLLER BEARINGS

PRODUCTION ECONOMICS...

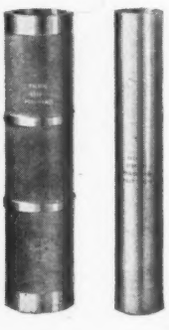
by Pacific PUMPS INC.

	QUESTION		ANSWER
Q	*Why is oil at the bottom of the well like money in a safe deposit box?*	A	Because it is a LIQUID ASSET IN DEAD STORAGE WITHOUT EARNING POWER.
Q	*Can this condition be changed?*	A	Yes — both can be activated and given earning power.
Q	*How can they be activated?*	A	Draw some of the money from the safe deposit box — purchase and install a Pacific Oil Well Plunger Pump in the well — pump the oil to the surface. MONEY IN CIRCULATION — OIL IN CIRCULATION — BOTH WITH POWER TO EARN.
Q	*Why purchase and install Pacific Oil Well Plunger Pumps?*	A	Because only Pacific gives you the EXCLUSIVE MOLOY® LINERS with the strength, toughness, hardness, combined with greater resistance to temperature, corrosion and abrasion essential for long, economical life.



Plungers — Chrome-Plated then Pacilited for extra wear life.
Valves and Seats —To fit well conditions.
Extra Heavy Seats — Resist hammering of ball with less chance of distortion.

PACIFIC *Precision Built* PUMPS



DW-6

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Monument, Plaque Mark Site of Midway Gusher

The Petroleum Production Pioneers, Inc., recently placed a monument and inscribed bronze plaque at the site of Chanslor Canfield Midway Oil Company's well No. 2-6, the first gusher in the Midway, California area. This well came in over the derrick on November 27, 1909, for an estimated flow of 2000 bbl a day, and began one of the greatest booms in San Joaquin Valley history. Also honored was Fred C. Ripley, Sr., who initially chose the site of the well, and was responsible for its subsequent success. He was then assistant manager of oil properties for Santa Fe Railway coast lines, and later became manager of the Chanslor Canfield Company, with which he was associated for some 45 years.

Kansas Men Tour Water-Flood Projects

The Kansas section of the American Institute of Mining and Metallurgical Engineers toured Greenwood County, Kansas recently, inspecting the water flood projects. They included the Thrall-McKee consolidated water flood of Sinclair Oil and Gas Company; Martindale flood of the Ohio Oil Company; Teeter Unit flood of Cities Service Company, and Polhamus flood of Sohio Oil Company.

Venezuelan Crude Oil Production Up in October

The Colon Development Company, Ltd., has reported that in Venezuela oil production for four weeks ending October 1, 1951 amounted to 354,253 bbl. This compared with 438,712 bbl reported for five weeks ending September 3.

Florida Lease Granted

The Commonwealth Oil Company of Miami, Florida, has been granted 10-year leases of 885,000 acres of state-owned waterbottom lands along the extreme northwest coast of Florida. At least one well must be drilled within six months. Lands are in or adjacent to Escambia, Santa Rosa, Okaloosa, Walton, Bay, and Gulf counties.

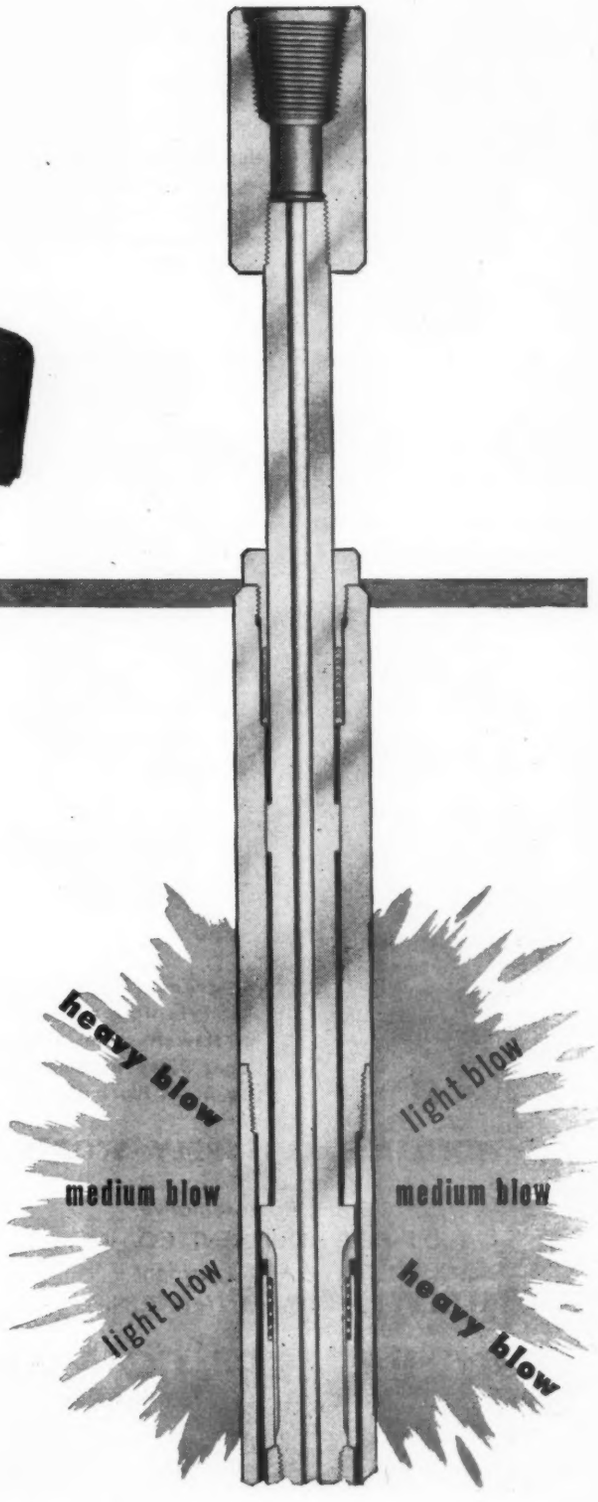
Recovery Conference Bulletin Available

The Texas Petroleum Research Committee announces the publication of *Proceedings for Second Oil Recovery Conference — a Symposium on Carbonate Reservoirs* held at Texas A. and M. College last April 19 and 20, as Bulletin 11 of Committee publications. Bulletin 11 contains 17 papers in addition to a letter of greeting from Governor Allan Shivers and an address of welcome by Chancellor Gibb Gilchrist.

The volume of 205 pages including illustrations is multilithed and may be obtained upon application to George H. Fancher, Director of the Texas Petroleum Research Committee, Petroleum Engineering Building, A. and M. College, College Station, Texas.

Jarring Jerry

The right jar for the job at hand



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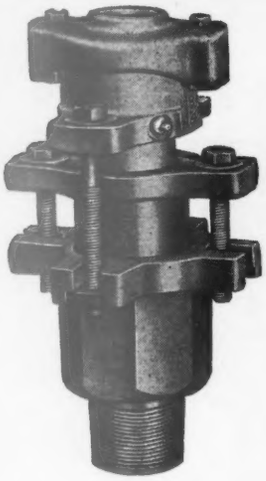

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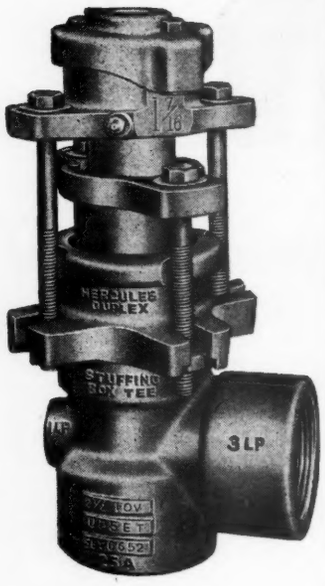

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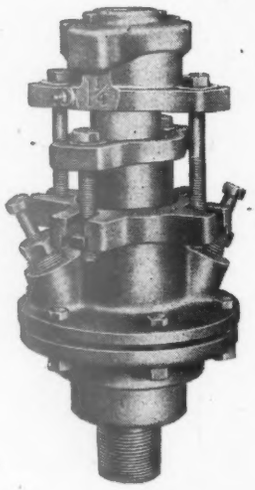

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Institute of Petroleum Discusses Unproduced Oil Reserves

At the meeting of the Institute of Petroleum recently, Dr. Morris Muskat, Ph.D., Gulf Oil Corporation delivered a paper on "Our Unproduced Reserves; What are they?" The paper discussed the *unproduced* rather than the undiscovered petroleum reserves of the United States, these unproduced reserves being the anticipated recoveries by *present producing methods.*

In the United States the applied science of producing and understanding the performance of oil reservoirs has been termed "reservoir engineering". Two basic principles stand out as fundamental: (1) each reservoir is a unique physical system demanding individual analysis and treatment in the light of its own peculiar characteristics, and (2) the gross performance of and recovery from a reservoir are not expressions of an immutable preordained history, but are dependent on the nature of its development and of the production practices imposed thereon. The corollary with respect to reserves of this latter proposition is self-evident.

Since 1940 statistics show that new or "modern" fields have been discovered which will have an ultimate recovery, by present operations, of some 23 billion barrels of crude oil. If it is assumed that two-thirds are now producing to achieve maximum recovery and that the recovery in the remainder will ultimately be increased by 50 per cent, there is a gain of 4 billion barrels. Also, if one-third of the "older" fields discovered prior to 1941 are subjected to secondary recovery operations and the previously estimated reserves increased by 50 per cent, the gain will be 7 billion barrels. A round figure of 10 billion barrels is suggested as being of the right order of magnitude as to what can be done.

Reviewing the possibility of increasing present reserves by application of new engineering developments, Dr. Muskat referred to three recently reported types of laboratory research investigations. The first relates to the effect of a free gas phase on oil recovery by water displacement, by which it might be possible to increase recoverable reserves by 34 per cent over the "perfect" water drive.

Another type of research pertains to gas drive and shows that if the gas is injected at pressures much higher than the reservoir pressures, and if the injected gas be relatively rich in intermediate components, the ultimate recovery will be substantially increased.

A third method of reducing residual oil saturation is the use of miscible solvents, e.g. LP gases. These can, in effect, wash a sand clean of its oil content but economic factors may raise serious questions as to practical application.

In conclusion Dr. Muskat considered that the extensive research now being devoted to improved oil recovery operations will lead to substantial rewards and the additional recovery of several thousand million barrels of crude oil is a conservative estimate.

Manabi Extends Ecuador Oil Search

A shallow wildcat drilling program was begun in Ecuador by Manabi Exploration Company, Inc., of Houston, Texas, recently. The company's No. 1 Matilda, a 3000-ft test to the Atlanta Sandstone, is now below 400 ft. Three 5000-ft tests have been set in the company's 87,000-acre Engunga Concession about 30 miles southeast of the Tigre field.

Since the first of the year, six wells have been drilled, with one producing an average of 325 bbl daily since May. One of the wells was drilled to test the shallow Socorro section in the Tigre field and the well is producing 40 bbl of oil daily from 560 ft.

During the first six months of the year, Manabi Exploration had high initial operating costs and, as it produced only 1150 bbl of oil per day, just met operating expenses. The third quarter, with the production of 1600 bbl a day and much lower operating expenses it showed a substantial profit.

The company's concessions extend from the northern part of Ecuador to within 50 miles of the Peruvian border. Besides the 980,000-acre concession in the central coastal area of Ecuador which was taken over when the company was formed in 1949, the Ecuadorian government has granted the company concessions comprising about 1,600,000 acres.

How to Prevent Flooding of Exhaust Manifold

Use of water in the engine exhaust as a safeguard against possible fire while completing a well with a mechanical rig is a requirement enforced by many major companies and means for this are provided by most drilling contractors.

When the water connection is welded into the exhaust line, it sometimes happens that the water will be left running when the engine is shut down. Then, if the exhaust line does not pitch downward away from the engine, water may work back into the manifold and cause serious damage.

One contractor welds a dog-leg in his exhaust lines, offsetting the outer end of the line downward for half a diameter of the pipe or more. The quenching water is introduced at the lower end of the dog-leg and any water that may accumulate is trapped against backflow into the manifold by the riser of the offset.

Introducing water at the change in direction of the line is also believed to assist in the formation of a spray that wets the entire stream of exhaust gas, insuring cooling of the hot gases and quenching of any incandescent sparks of carbon that may be carried by the hot gases.—E. S.

Austrian Oil Output Is Reported Higher in 1951

Production in Austria will increase about 18 per cent during 1951, it has been reported. During 1950 oil output averaged about 34,000 bbl per day, however, this will be stepped up to average about 40,000 bbl daily this year.

Beside the old Zistersdorf oil area, increased production is coming from new fields at Bockfliess and Anderlaa, in lower Austria. The two new fields make up about 30 per cent of Austria's oil out put. Oil is also coming from the Matzen area, which produces about 40 per cent of Austria's total oil supply.

An increased exploration program is on at the present time, according to current reports, concentrated mainly in Burgenland, near the Hungarian border. Soviet is said to be director of the Austrian oil industry.

New Gas Well Drilled

Butler Johnson Service Corporation has a new gas-distillate discovery in Caddo Parish, Louisiana. The No. 1 Sentell has an open flow potential of 37,000,000 cu ft gas daily by unofficial test. Total depth was 8350 ft.

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Unit is yours!

We build JENSEN Units only for you—to make your wells more profitable, more dependable, more satisfactory.

We have never authorized the sale of a JENSEN Unit to any producer anywhere unless we thought it was likely to be the best investment he could make. This has been our iron-bound policy for 30 years.

So, you can safely "shop" for a JENSEN without fear of high-pressure selling. We don't want your business unless we can help you.

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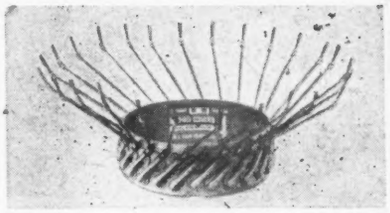

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1. SCRATCH ON THE UP-STROKE won't "tear up" the hole while running in.
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AXELSON MANUFACTURING CO. • PLANTS—Los Angeles 58; St. Louis 16 • OFFICES—New York City 7 Tulsa 1; Buenos Aires, Argentina; Caracas, Venezuela • DISTRIBUTORS—Jones & Laughlin Supply Co.; Great Northern Tool & Supply Co.; Industrial Agencies, Ltd., San Fernando, Trinidad, B.W.I.; Industrias Waldrip & Campbell, Barcelona & Maracaibo, Venezuela; Dominion Oil Field Supply Co., Ltd., Calgary, Canada; South American Supply Co., Avenida Tacna 592, Lima, Peru.

Additional Natural Gas from Ventura Area

An additional supply of natural gas will soon be available to the Southland from the Ventura area as a result of increased drilling activity and production of additional volumes of natural gas. The increased gas production in the Ventura Avenue field north of Los Angeles is requiring the expansion of Southern California and Southern Counties Gas Companies' pumping facilities to handle the additional volumes of gas.

Delivery of natural gas from the Ventura field in 1950 averaged 76,200,000 cu ft a day. First indication of the increased production came in June, when the expected delivery of 81,300,000 cu ft rose to an actual 88,900,000 cu ft per day. The expected delivery of 81,500,000 cu ft climbed in July to an average of 88.4 and in August the expected delivery of 81.8 soared to 92.7. By 1955, it is estimated the daily delivery will reach 110,700,000 cu ft.

Increased drilling activity in the Ventura area caused the number of estimated producing wells to increase from 720 to an actual 752 by June, 1951. Estimates of further increases in the number of producing wells in this area show 842 for 1952, 904 for 1953, 960 for 1954, and 1001 for 1955.

Production Division Plans Spring Meeting

The Southwestern district, Division of Production, American Petroleum Institute will hold its spring meeting at the Washington-Youree Hotel, Shreveport, Louisiana, March 5-7, 1952.

Program Committee will accept all suggestions from members. They should be addressed to B. R. Schabarum, chairman, Carl B. King Drilling, Midland, Texas, or any other member of the committee, which includes:

E. N. Van Duzee, Shell Oil, New Orleans, Louisiana; R. B. Saxe, Gulf Oil, Odessa, Texas; Louis Davis, Atlantic Refining, Dallas, Texas; Paul McDonald, C. H. Murphy Company, El Dorado, Arkansas; Ben F. Carter, Union Producing, Shreveport, Louisiana; E. H. Dial, East Texas Salt Water Disposal, Kilgore; T. J. Fuson, Humble Oil, and S. C. Oliphant, Stanolind Oil and Gas, Houston.

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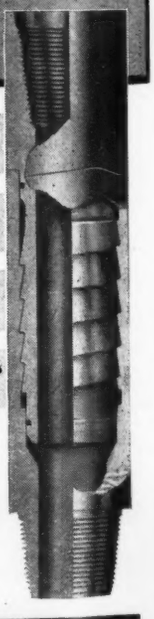

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BOWEN SAFETY JOINTS fit right into your present string as a regular sub with no out-of-size dimensions. They have the same outside diameter and fluid passage as its corresponding size tool joints, and BOWEN SAFETY JOINTS are dependable on the toughest drilling, testing and fishing operations.

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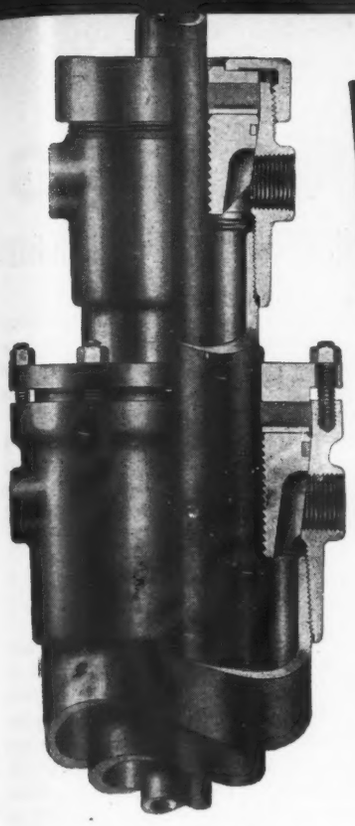
RECTOR REDHEAD

gives you widest variety of low-pressure casing and tubing head arrangements.



Type R Forged Steel Casing and Tubing Heads

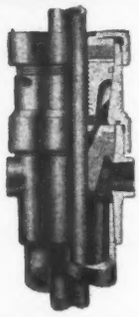
Designed and manufactured by the industry's leading producer of high pressure heads, the RECTOR REDHEAD has innumerable features that put it far ahead of the field of low cost, low pressure, forged steel casing and tubing heads.

Ruggedly constructed, the bodies have greater thickness and strength than any casing or tubing to which they will be attached. Case hardened slips are three-segment type with ribbed construction to permit full flow to the outlets. An oil resistant pack-off rests on a split junk ring directly on the slips. On the casing heads this packing is secured by a split gland bolted to the head body. On the tubing head it is secured by a gland tightened down by a screw cap on top of the head.

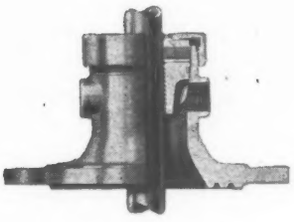
A slip bowl adapter is available to carry slips, packing and gland so that a stripper can be carried in the tubing head body. Stripper and slips are interchangeable in bowl and head body so that two strippers can be used.

Type R Casing and Tubing Heads are available with flanged or threaded bottom connection. Male threaded and flanged drilling adapters are available for screwing on top of the Tubing Head. A special threaded mandrel is available when head is used with Kobe Pump.

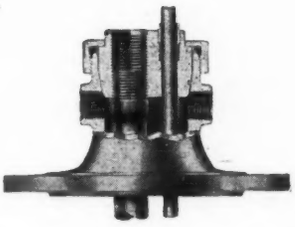
Ask your nearest Rector Representative, authorized Supply Store, or write for complete details about the Rector Redhead.



● Threaded bottom Type R Tubing Head with slips and stripper. For workover jobs a second stripper can be used in place of the slips in the adapter bowl. Slips and stripper are interchangeable in head and bowl.



● The Type R Tubing Head with light flange for use on low pressure well having a flanged casing head . . . or to replace high pressure tubing head and tree when changing from flowing to pumping conditions.



● The original tubing head installation can be adapted to the Kobe Pump simply by using the special threaded mandrel with stuffing box for the power lines. The mandrel, resting on a ground joint seat, has an "O" ring seal.

● Type "R" Casing Head with threaded bottom. Notice how ribbed construction of slips permits full flow to side outlets, also simplicity and effectiveness of sealing arrangement.

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WHAT'S DOING IN DRILLING

Texas Gas Field Gets First Oil Production

The recently discovered Blackjack gas pool, three miles northeast of the St. Charles Ranch gas field, in Aransas County, Texas, has yielded its first oil production with the completion of the St. Charles Well No. 16, jointly owned by Continental Oil Company and Western Natural Gas Company.

On completion test the well flowed at the rate of 240 bbl of 48.7 gravity crude on ¼-in. choke in 24 hours and produced 196,000 cu ft of gas. It was completed in the Frio zone, producing through perforations from 8288-98 ft.

The St. Charles No. 13 gas well, producing from 10,320-60 ft, brought in the Blackjack gas pool last summer.

Iowa Field Is Scene Of Roussel Producer

A new producer has been drilled in the Iowa field of Calcasieu Parish, Louisiana. It is the No. 2 Haggert drilled by Louis J. Roussel. Perforations were placed at 11,023-34 ft and the flow through 12/64-in. choke was at the rate of 3,100,000 cu ft of gas per day and 332 bbl of 50-gravity condensate.

Sunray Gets Extension Producer in Texas Bay

A westward extension of the Red Fish Bay-Mustang Island oil pool of Nueces County, Texas, being developed by Sunray Oil Corporation, is indicated by the completion of Sunray's well on State Tract No. 353-1 brought in to produce at the rate of 360 bbl of high gravity crude on 12/64ths in. chokes in zone 14 at 8239-48 ft. Coring tests made while Sunray's new well was being drilled indicate the presence of six possible oil producing sands and three zones containing gas-distillate production possibilities.

Vasen Well Below 20,000 Ft

According to reports, George Vasen and associates' No. 1 Tung Oil Corporation in Stone County, Mississippi, has been drilled to 20,450 ft, about 200 ft under the world's depth mark. The well is about to receive casing so the deep wildcat may be cleaned out and deepened for the depth mark hit by Superior Oil Corporation.

Hunt Well Complete

H. L. Hunt has completed the E-5 Fisher Lumber Company as the second producer at Lisemore Landing in Concordia Parish, Louisiana. The new well flowed 149 bbl of oil daily through an 8/64th-in. choke from perforations at 5850-55 ft. Gas-oil ratio was 250-1, and total depth 6500 ft.

Union Oil Drills Test In Cut Bank Oil Field

Union Oil Company of California has announced a new test in the Cut Bank field of Montana. The test is aimed at the Devonian formation, which has been productive in recent Williston basin developments. The well is reported to be situated in a huge productive area on the west flank of the Kevin-Sunburst uplift, in which no previous attempt has been made to determine productive possibilities of zones beneath the Madison lime, and Cut Bank sands. The Montana Oil and Mining Journal reported that the only previous deep test ever drilled between the Kevin-Sunburst flank and the Rocky Mountains is 12 miles northwest of the present location. It was drilled by Union Oil and found shows in the Devonian, but zones were too hard and tight for production.

API Bulletin Available

A special bulletin of the American Petroleum Institute's Division of Production, "The Effects of Drilling-Mud Additives on Oil-Well Cements," is off the press. This publication, sponsored by the API Central Committee on Drilling and Production Practice, is a special report of the Mid-Continent district study committee on cementing practices and testing oil-well cements. The report contains 40 pages, including 265 tables and charts, summarizing the data obtained from a series of cooperative tests conducted by the study committee to determine the effect of several drilling-mud treating chemicals on the thickening time and strength of three types of commercial cement commonly used in oil-well cementing operations.

The bulletin, which is designated D-4, is available at $1 a copy from the Institute's Division of Production, 816 Rio Grande National Building, Dallas 2, Texas.

New Drilling Firm Plans Operation in Mississippi

Northeast Mississippi Oil Company, a Delaware corporation, was formed recently with its principal operations planned in Mississippi. The company announced its intention to acquire and develop old abandoned oil and gas wells in Mississippi and to acquire by direct lease or other means leaseholds for oil and gas development.

Malcolm N. McCaskill, Aberdeen, Mississippi, is the president of the firm, and Anice H. Nason is secretary. Other incorporators are Howard G. Nason, Aberdeen, and Charlie McCamic, Wheeling, West Virginia.

Magnolia Drills Offset To Crossroads Field

Magnolia Petroleum Company has a new well in Lea County, New Mexico as direct offset to the Crossroads field. The No. 1-B Santa Fe was completed for a 24-hour natural flowing potential of 396 bbl of 44.2 gravity oil through a ¾-in. choke from open hole at 12,130-137 ft. Gas-oil ratio was 21-1.

Drilling Company Formed; Offices in Midland, Texas

The Clark Dale Drilling Company, Inc., a newly organized oil well drilling firm with main offices in Dallas, will establish operating headquarters in Midland to serve the Permian Basin and New Mexico.

Officers of the company are Charles E. Dimit, of Dallas, president, Creston Alexander, vice president; Dale M. Thomson, of Midland, vice president; J. M. Clark, of Midland, vice president and A. M. Early, of Dallas, secretary-treasurer.

Dale M. Thompson

J. M. Clark

The operations office in Midland will be opened as soon as suitable space can be obtained. Dallas offices of the company are in 903 Continental Building.

Clark, who will be in charge of the company's drilling equipment, has for the past 25 years been actively engaged in drilling and production operations with several drilling contractors and producers from the Rocky Mountain area to the Gulf Coast.

Thomson has had 23 years experience in the drilling and oil well servicing business, and was associated with a drilling company in Oklahoma before moving to Midland two years ago.

When squeeze troubles seem only minutes away...

UNAFLO* STOPS THE CLOCK

WHEN you're squeezing deep down a hot hole... and delays crop up... Unaflo gives you vital extra time. Why? Because Unaflo is a *retarded* cement —not merely "slow-setting." It stays fluid and pumpable throughout the retardation period and allows more time to complete the job.

This safety factor of Unaflo has been proved in the laboratory (see chart) and in the field—where pressures over 4,000 p.s.i. combine with temperatures above 100°F.

On your next squeeze job, use Unaflo. It will protect your investment three ways:

EASY FLOWING—Unaflo's high *initial* fluidity makes pumping easier.

SUSTAINED FLUIDITY—Unaflo *stays* fluid and pumpable throughout the retardation period. There's ample time, even in emergencies, to get the cement in place.

HARDENS NORMALLY—Unaflo, after its retarded period, makes a *strong* tight seal—resistant to sulfate waters.

Helpful free bulletin gives facts-and-figures comparison of Unaflo's well-bottom performance with that of other cements. For your copy write: Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

LABORATORY TESTS SHOW UNAFLO'S DELAYED, RETARDED SET

Stanolind Pressure Thickening—Time Tester

Thickening time—40% mixing water. Slurry weight: 16.5 lb./gal.

Tests made by Universal Atlas Research Laboratories in accordance with methods of API Code 32, 2nd edition, 6/50.

WELL CONDITIONS			Viscosity in Poises at time (Hrs.-Min.) Indicated								Thick. Time
Well Depth (Ft.)	Max. Temp. °F.	Max. Pressure-psi	0	0:15	0:30	1:00	1:30	2:00	3:00	4:00	Hr.-Mn.
6000	113.0	3867	6	8	8	10	10	10	24	77	4:03
8000	125.0	5156	6	7	8	8	8	15	45		3:15
10000	144.0	7484	7	7	6	6	7	8	63		3:03
12000	172.0	10227	11	11	12	12	11	18			2:31
14000	206.0	13386	10	11	11	14	17	20			2:25
16000	248.0	16144	9	9	10	11	19				1:41
18000	300.0	18800	8	8	8	8	47				1:33

"UNAFLO" is the registered trade mark of the retarded oil-well cement manufactured by Universal Atlas Cement Company

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Atlas Portland Cement—Type I

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Oklahoma Well Flows 590 Bbl of Oil in 14 Hrs

A new well in Stephens County, Oklahoma, flowed 144 bbl of load oil and 590 bbl of new oil in 14 hours through a ¾-in. choke. It is Bay Petroleum's No. 3 Payne, which was perforated between 5578-5610 ft, 5835-45 ft, and 5852-75 ft. Later the well flowed 377 bbl of oil in 24 hours through a ¼-in. choke and then made 218 bbl in 24 hours through a 1/64-in. choke.

Delaney Deepens Oil Well

An old oil producer in the West Bethel pool of Seminole County, Oklahoma, has been deepened by W. A. Delaney, Jr., and completed as a flowing well. It is the No. 1 Edmond, which is completing in the Hunton lime. Formerly drilled at 3281 ft in the Booch sand, the well has been carried to 4095 ft and the zone below 4094 ft treated with acid. After cleaning up, the well flowed 280 bbl of oil in 24 hours through a ¾-in. choke.

New Producing Horizon Hit In Wyoming Oil Field

Pure Oil Company has announced a new oil-producing horizon in a new well on the northeast side of the Worland, Wyoming field. The well has an initial production of about 800 bbl per day of 41-gravity oil through ¼-in. choke. It is in the second sand of the Frontier series, which produces gas and condensate higher on the formation.

The well's producing level at 7841 ft is approximately 600 ft below the highest part of the reservoir. The Worland field has three producing sands in the Frontier series and also produces from the Embar limestone at about 10,000 ft.

California Field Well

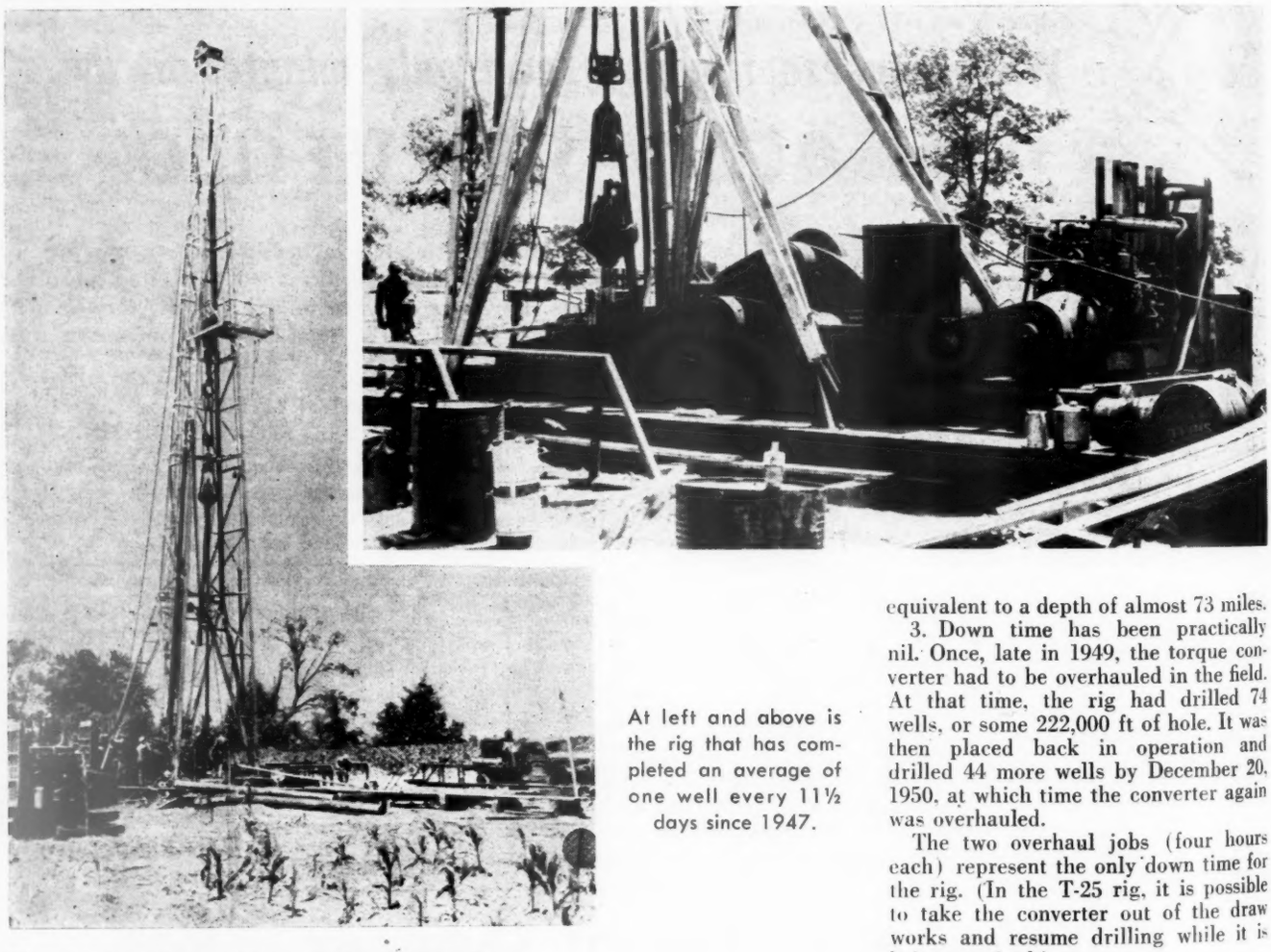
Shell Oil Company has reported its Taylor 348, oil well, which has been drilled to 11,510 ft in the Ventura Avenue field, California. The well was completed flowing at the rate of 1174 bbl daily of 29.6 gravity crude oil through a 20/64-in. choke.

Two Gas Wells Completed In Virginia Gas Field

Two gas wells have been completed in the Nora natural gas field of Dickenson County, southwest Virginia. On a one-hour test, one well, drilled by Clinchfield Coal Corporation, produced at the rate of 1,048,00 cu ft of gas a day and the other slightly under 500,000 a day. The company's 19 wells have an aggregate open-flow capacity of about 29,000,000 cu ft of gas a day, now shut in. Clinchfield Coal is a subsidiary of Pittston Company.

Continental Drills Well In Velma Pool, Oklahoma

Continental Oil Company has completed a well in the Velma pool of Stephens County, Oklahoma, its No. 4 Martin "C". The well flowed 455 bbl of 36.6 gravity oil in 24 hours through a ½-in. choke, plugged back depth 4400 ft. Production is from the Eason sand through perforations between 3957-88 ft.



At left and above is the rig that has completed an average of one well every 11½ days since 1947.

Rig Is in Operation After Four Years

Skiles Oil Corporation's National Supply Ideal Type T-25 consolidated rig first went into operation in May 1947 at Grayville, Illinois. It then drilled 29 wells, or about 87,000 ft of hole. Purchased by Skiles in June of 1948, it is now being used on drilling operations at Pomeroy No. 1 in White County, Illinois. The officials cite these facts:

1. In the first four years of its life the rig has completed an average of one well every 11½ days.

2. As of June 11, 1951, the T-25 has drilled 384,562 ft of hole in 129 wells; equivalent to a depth of almost 73 miles.

3. Down time has been practically nil. Once, late in 1949, the torque converter had to be overhauled in the field. At that time, the rig had drilled 74 wells, or some 222,000 ft of hole. It was then placed back in operation and drilled 44 more wells by December 20, 1950, at which time the converter again was overhauled.

The two overhaul jobs (four hours each) represent the only down time for the rig. (In the T-25 rig, it is possible to take the converter out of the draw works and resume drilling while it is being repaired.)

4. Cost of corrective maintenance has been a minimum. For instance, the rig is still operating with its original set of brake drums.

What its future will be is not known, although it is thought that the rig will next be moved to Texas for 5000-ft drilling. ★ ★ ★

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GLOBE patented "2-Cutter" and "4-Cutter" ROCK BITS

FIRST IN SERVICE EVERYWHERE

Bigger cutters with larger bearing area feature the new, improved design of Globe "2-Cutter" and "4-Cutter" Rock Bits . . . cutters that *naturally* last longer, digging more hole, faster! In addition, they are free-running and maintain perfect alignment during the entire life of the bit. The Globe service organization is available at all times to help you select the drilling bit best suited to the conditions in your well. *For greater drilling economy, use Globe Drilling Bits.*

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EXPLORATION ACTIVITIES

Kansas Wildcat Flows 162 Bbl of Oil Daily

The Texas Company has reported that its wildcat, No. 1 Keenan, in Jennings, Kansas, has been completed for a state production potential of 162 bbl of oil daily. The wildcat is producing from Upper Lansing-Kansas City rocks, topped at 3043 ft and perforated from 3478-82 after the hole had been cut to 3894 in granite and plugged back to 3503.

Second Wilcox Test in Oklahoma Successful

The Cummings-McIntyre et al No. 1 Combs has opened a new productive area in Grant County, Oklahoma. Five miles west of the Rich Valley pool, the Combs has indicated production with a drillstem in the Marshall zone and second Wilcox at 5960-79 ft. Seven-inch casing had been cemented at 5963 ft, in the Marshall. When plug was drilled, the 16-ft section of open hole flowed oil at the rate of 100 bbl hourly, quickly filling two 210-bbl tanks set for initial production testing.

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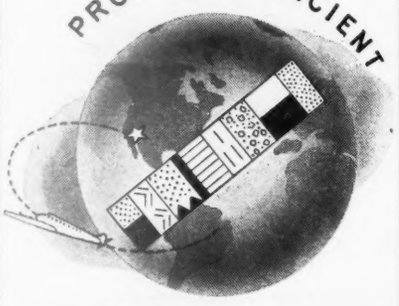

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PASADENA 2, CALIFORNIA

New Oil Area Opened In Galveston County

A new well, flowing 22,600,000 cu ft of gas daily, open flow, has opened a new producing area in Galveston County, Texas. On final potential gage, Hassie Hunt, Trust, Estate 1 Mike David was drilled to a depth of 9971 ft and is producing from 9947 to 9971 ft. The wildcat producer is shut in.

Liberty Oil Drills Mississippi Gas Well

Initial tests indicate a rich gas-condensate producer in Forrest County, Mississippi. It is the Liberty Oil Company's No. 1 Crosby. Operators perforated interval 8074-85 ft, and cleaned to pits on ¼-in. choke with tubing pressure of 650 lb. Choke was changed to 3/16-in. and well flowed for 3 hours with tubing rising to 2200 lb.

Two Tests Set For San Juan Basin

Two tests will be drilled in the eastern side of the San Juan basin in New Mexico. The Albuquerque Associated Oil Company has contracted with Mission Petroleum Company, Los Angeles, California to drill the tests. The first test will be drilled in Rio Arriba County, by cable tools. It is designed to test the Mesa Verde sand estimated at around 4000 ft. Second test will be a mile and one-half west and will be drilled by rotary to test the Dakota sand.

Amerada Drills Second North Dakota Wildcat

Amerada Petroleum Company has reported a new well in North Dakota's Williston Basin. The well is the company's No. 1 Dilland. A 4-hour drillstem test was run from 8396-444 in what has been tentatively identified as the Madison lime. The test kicked off and flowed 219 bbl of oil in 4 hours through ⅝-in. choke. Gas volume was 2,000,000 ft per day. The new discovery is a mile and a half north of the original pool opener, Amerada No. 1 Clarence Iverson.

New Oil Field Likely For Kansas County

A new oil field appears likely for Barton County, Kansas at the Rocket Drilling Company's No. 1 Putnam. The well cut the Lansing-Kansas City Lime zone at 3224 ft and a 1-hour drillstem test at 3247-97 ft recovered 420 ft of heavily oilcut mud. Initial tests showed 2 bbl of oil an hour.

Prospects Discovered For New Canadian Oil Field

British American and Cities Service have discovered what appears to be a new oil field near Clive, Alberta, about 30 miles northeast of Red Deer. The well, Clive No. 1, found the top of the D-2 at a depth of 6190 ft and the first D-2 porosity at a depth of 6227 ft. On a 15-minute formation test of the interval 6227 to 6231 ft the well had gas to the surface in 3 minutes at a rate of 400,000 cu ft per day. Oil reached the surface in 12 minutes at a rate in excess of 50 bbl per hour. Recovery in the drill pipe consisted of 2830 ft of 38.8 gravity oil with no water.

The well is now coring and testing ahead. Plans are to carry it to the D-3 before completing.

Arkansas Wildcat Well Completed For Production

McAlester Fuel Company has completed a new well in Union County, Arkansas. The wildcat was given an initial production of 114 bbl of oil plus 2 per cent salt water from 3780-89 ft. The well is a mile and a half northeast of the Bear Creek field.

Plymouth Drills Well In Benedum Field, Texas

Plymouth Oil Company has a new well in the Sprayberry sand in the Benedum field, Upton County, West Texas. It is the Neal 1-8, which had an initial flow of 531 bbl of oil a day, on a ½-in. choke. It was 40 gravity and gas-oil ratio was 732-to-1.

West Texas Test Set

A 6100-ft Ellenburger test in Haskell County, Texas, on the 37,000-acre Flat Top ranch, has been announced by Cities Service Oil Company (Delaware). A joint-interest well with Lone Star Producing Company and Signal Oil and Gas Company, the wildcat is Flat Top 85 No. 1. It is four miles northeast of the East Hamlin pool, nearest commercial production. This is the fourth wildcat on the big Flat Top Ranch, one was a Swastika producer, one a KMA sand producer, and one a dry hole.

Ellenburger Zone Field Opened in Stephens, Texas

S. Caprito et al's No. 1 Compton-Hazelwood in Stephens County, Texas opened a new Ellenburger zone field. The well flowed 122.39 bbl of 41.6 gravity oil through a 8/64-in. choke, from perforated zone at 4173 to 4211 ft. Gas oil ratio was 816-to-1.

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Sunray Gets Another Spraberry Sand Producer

Its best well to date in the Spraberry sands of Upton County, Texas, has been completed by Sunray Oil Corporation to produce at the rate of 407 bbl of oil per day through a 17/64-in. choke. The well is Sunray's Sherrod Ranch No. 43-1, which indicates that a considerably larger portion of the company's 5000 acres of leases should be productive in the sands that appear to improve on the west edge.

The company's R. Sherrod No. 48-1 has also been completed to flow on test at the rate of 185 bbl per day on 17/64 in. choke.

Gas-Distillate Well Is Drilled in Louisiana

A gas distillate discovery well has been brought in in Cameron Parish, Louisiana, known as the Miami Corporation No. 1. The wildcat, drilled by Pan-American Production Company, was completed for a calculated open flow potential of 20,500,000 cu ft of gas daily from perforations at 12,324 to 12,344 ft and from 12,362 to 12,372. Total depth of the well is 12,378. Gas-distillate ratio is 27,000-to-1. The distillate is straw colored and has a corrected gravity of 46.1 deg.

West Texas Well Indicated

Prospects of a good oil well in Dawson County, West Texas have been found at the Greenbrier Oil Company and Mendota Oil Company's No. 1 M. C. Lindsey. The wildcat swabbed down to kick off, then flowed 21 bbl of clean oil in 12 hours through a 5/8-in. and 1-in. chokes after perforations at 10,957-967 ft. Maximum tubing pressure was 1300 lb, and gas-oil ratio was 947 to 1.

Lion Oil Opens New Mississippi Oil Field

A new oil field has been opened in Franklin County, Mississippi by Lion Oil Company at its No. 1 Thomas. The new well has been drilled to 7218 ft, and casing perforated at 6381-87 ft and flowed at the rate of 150 to 200 bbl of oil a day through a 1/64-in. choke. Oil is 39 deg gravity. The new well, which is the third Wilcox sand field for this county, is about six miles south of the South White Apple field.

Ohio Oil Tests Basin In Western Nebraska

A new oil field is believed to have been opened in the East Brownson area of the Denver-Julesburg basin in Western Nebraska. The Ohio Oil Company's test of the "D" sand, topped at 4752 ft, recovered oil in the Cheyenne County well and the company cored to test the "J" sand.

Illinois Has Big Producer

J. H. Gilliam and Ted Lindsay have a heavy oil flow in Wabash County, Illinois. A new well, the No. 1 Miller flowed 168 bbl of oil the first hour after the plug was drilled. The discovery is O'Hara limestone at 2840 to 2844 ft. The well is 2 miles from other wells.

Wyoming Test Complete

Morton Brothers recently completed its No. 1 Rauner in the Julesburg-Denver Basin, Wyoming, helping to confirm that basin as a 4-state field. The well wildcat showed in the "J" or Dakota formation, and is situated on Pine Bluffs high in extreme eastern Laramie county of southeastern Wyoming. The "J" zone was hit at 7465 ft.

Exploration Activities Are Increased in Pakistan

A test well is being prepared in Eastern Pakistan at Patharia, in the province of East Bengal. The Burmah Oil Company will drill the test. Equipment for the test is arriving in the area, and the well is expected to begin drilling next year. A diesel drilling rig, capable of going down 7500 ft will be used.

Before the war two previous test wells were drilled in the Patharia Forest area. One produced a certain amount of oil, but subsequently ran into difficulties and was abandoned. The other was a dry hole. New operations will be carried out in accordance with the Pakistan Petroleum Rules issued in September 1949.

The government of Pakistan has announced its intention to leave the exploration of oil resources in the hands of private enterprise, and has already granted several 30-year oil mining leases. Applications for oil explorations licenses in areas of both Eastern and Western Pakistan not already leased are invited from American companies.

Standard Vacuum Oil Company has announced that Pakistan has granted it rights to make aerial surveys of oil possibilities in the eastern part of the country. A company spokesman stated that the company will make airborne magnetometer surveys in the eastern and Bengal Basin area, which includes part of India.

The spokesman also said that an earlier report stating that the company had been given permission to drill in both east and west Pakistan was in error. He emphasized the company had been granted no drilling rights.

Oklahoma Wildcat Set

Sunray Oil Corporation has announced a new wildcat well in Pottawatomie County, Oklahoma, which may open a new oil field in that state. It is Sunray's State of Oklahoma C. No. 1, which has recovered 4675 ft of 24-26 gravity oil in a one-hour drillstem test. The Hunton lime group of sands was encountered at 5191 ft, with the first oil show on a 1-hour drill stem test at 5192-5210 ft with gas coming to the surface in 4½ minutes. Flow pressure was 1610 lb and bottom hole pressure was 1980 lb.

Wildcat Distillate Well Drilled by Sunray Oil

A new wildcat gas-distillate discovery is reported by Sunray Oil Corporation in completion of its Gus F. Baacke No. 1, Dewitt County, Texas.

The new Sunray well is on a 420-acre lease three miles north of the Slick-Wilcox field of Dewitt County and is situated 660 ft out of the northeast line of the Enock Jones survey. The lease is on a seismic prospect shot in 1945.

Testing on a 20-minute open hole drill stem test Sunray's wildcat recovered 230 ft of 58 gravity distillate in the drillstem. The well is being completed to produce from 7580-86 ft.

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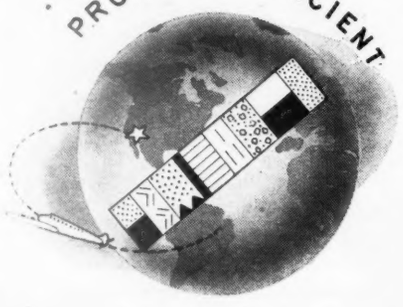

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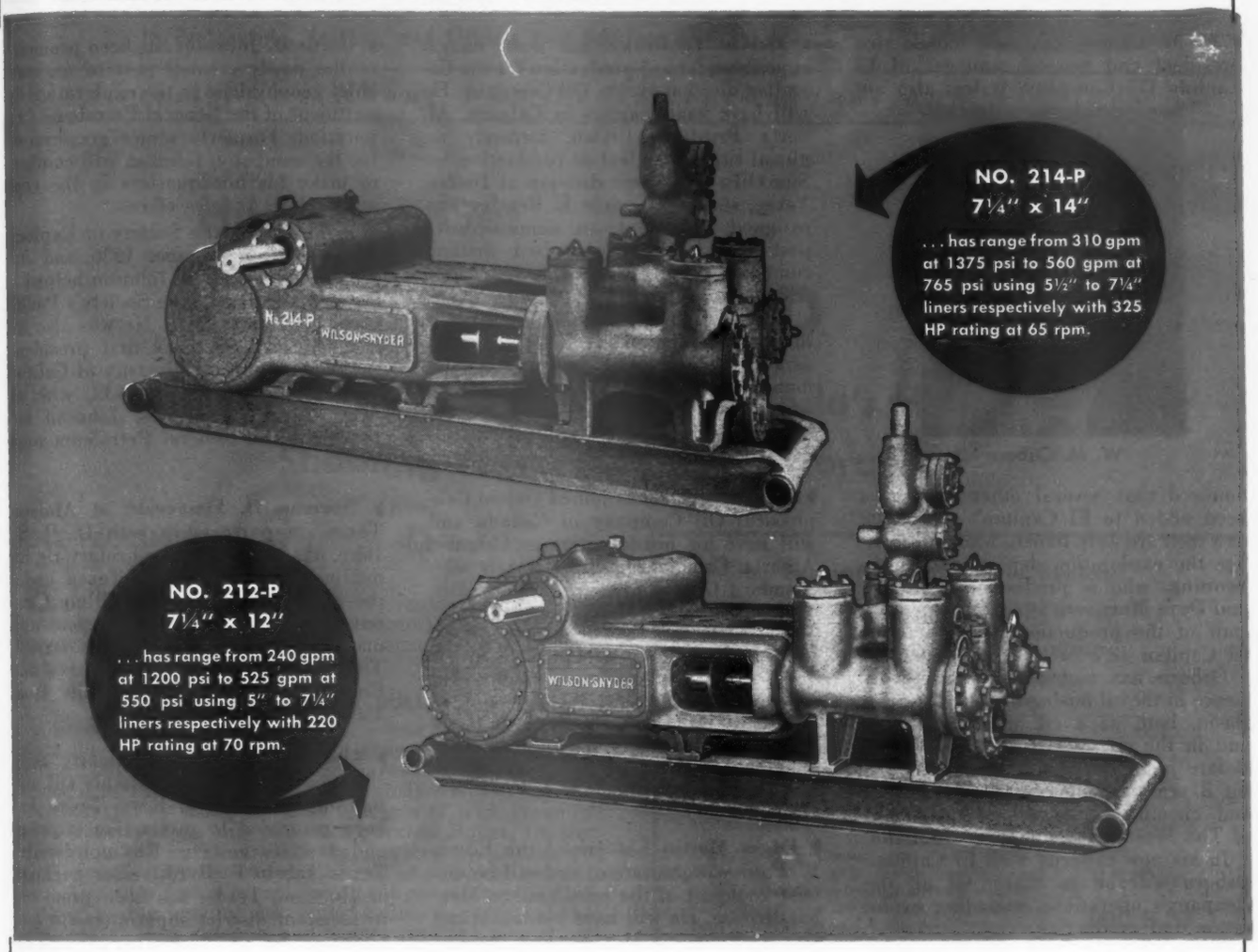
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Running tour with men in the industry

▸ **W. M. Osborn** has been named vice president and general manager of El Capitan Oil Company. It was also announced that several other men have been added to El Capitan's staff. The new men are **Lyle Brush,** who will manage the exploration department, **R. C. Senning,** who is production geologist, and **Dave Morrison,** who has joined the staff of the production department of El Capitan as a petroleum engineer.

W. M. Osborn

Osborn has had many years experience in the oil business of the Permian Basin, both as a consulting geologist and in the oil well servicing business. Before joining El Capitan, Osborn was for 8 years manager of the geological and chemical engineering department of The Western Company, of Midland.

In his new capacity with El Capitan, Osborn will be in charge of all the company's operations, including exploration and production.

Brush has also had many years of Permian Basin oil experience and was an independent lease broker in Midland before assuming the management of El Capitan's exploration department. Senning was on the geological staff of The Western Company for eight years before joining the oil company, and Morrison was formerly with George P. Livermore, Inc., in Lubbock. Both Senning and Morrison are graduates of the University of Oklahoma.

▸ **F. A. Menken** has been appointed a vice president of Tide Water Associated Oil Company and manager of exploration of the company's Western division. He succeeds L. C. Decius who retired after more than 35 years of service with Tide Water Associated.

Menken has been employed by Tide Water Associated since graduating from Stanford University in 1926 where he received his A.B. degree in geology and petroleum engineering. In addition to membership in the American Association of petroleum geologists and the American Petroleum Institute, he is a member of The Olympic Club of San Francisco and the California Academy of sciences.

▸ **Marvin L. Brown** has been named superintendent of production for the Canadian division of Sun Oil Company. He will have headquarters in Calgary, Alberta Province. Brown, formerly regional superintendent of production for Sun Oil's Southwest division at Dallas, Texas, succeeds George E. Bentley who resigned to accept an administrative post with a newly-organized drilling company. G. E. Dunlap continues as manager of the Canadian division.

Joining Sun Oil Company in Texas in 1919, Brown worked in various fields as a roustabout, gang pusher, and foreman before he was named an assistant superintendent of production for the company's Southwest division at Dallas in 1928.

▸ **R. G. Sohlberg** has joined United Geophysical Oil Company of Canada and will have his headquarters at Calgary, Alberta, Canada. He was formerly with Standard Oil Company of California.

▸ **C. A. Brooks,** area geologist; **A. D. Campbell,** senior landman; and **D. D. Windfield,** geologist for Stanolind Oil and Gas Company have been transferred to New Orleans, Louisiana. Formerly in Lake Charles, Brooks, Campbell, and Windfield will be in charge of Stanolind's newly created office in New Orleans.

▸ **Edgar Martin** has joined the Edwin W. Pauley organization, and will be district geologist of the northeastern Mexico division. He will have his headquarters at Reynosa, Mexico. For the last five years he has been an independent operator at Ardmore, Oklahoma. Prior to that he was geologist for Sun Oil Company at Ardmore, Oklahoma.

▸ **Curtis H. Johnson** has been promoted to the newly created post of assistant chief geophysicist in the exploration department of the General Petroleum Corporation. Formerly senior geophysicist for the company, Johnson will continue to make his headquarters in the company's Los Angeles offices.

A member of the Society of Exploration Geophysicists since 1936, and currently vice president, Johnson helped in the organization of the Society's Pacific Coast Section in 1948. He was also the Pacific Coast Section's first president. A graduate of the University of California at Los Angeles in 1932, with an A.B. degree in physics, Johnson has been with the General Petroleum since 1939.

▸ **Norman D. Fitzgerald** of Abilene, Texas, in partnership with D. D. St. John, has bought a second rotary rig for drilling in West Central Texas under the firm name of Saxon Drilling Company. Both are Brewster rigs, one with mastpole and one with jacknife derrick. They are now operating in Jones and Runnels counties drilling wells from 3500 to 4500 ft deep.

▸ **Clarence O. Magee,** formerly associate gas engineer for Humble Oil and Refining Company at Katy, Texas, has been promoted to production engineer and transferred to Raymondsville, Texas. **Edwin E. Byrd,** senior engineer at Houston, Texas, has been promoted to assistant district superintendent and transferred to Winters, Texas. **Virgil H. Jones,** Humble farm boss at Gladewater, Texas, has been promoted to assistant superintendent and will be stationed at Pickton, Texas.

Councilers and officers of the Petroleum Branch, Pacific Petroleum Chapter of the American Institute of Mining and Metallurgical Engineers. Sitting, R. L. Parsons, J. S. Baker, W. E. Glenn. Standing, C. R. Dodson, Paul Andrews, K. E. Barley, S. L. Wadsworth, H. E. Nissen, M. E. Loy, L. W. Chasteen, and B. P. Kantzer.

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Proof? Daily job reports from every major oil field (See a few typical jobs in the adjoining column) have one thing in common—MORE production, even after all other methods had failed!

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JOB DETAILS	RESULTS
1. Glenrock, Wyoming. Casing size: 5½"—17 lb. cemented in 9" hole. Tight and hard "Dakota" sand. Formerly jet perforated obtaining 62 B/D. McCullough Glass Jet Perforator shot 152 holes in 39 foot interval below 6,000 ft. Time on job 8½ hours.	62 B/D to 372 B/D
2. Olney, Texas. Casing size: 5½"—17 lb. cemented in 9" hole. Caddo lime formation. Formerly perforated without results. McCullough shot 120 Burrless Bullets in 30 foot interval around 5,000 feet. Time on job—2 hours.	0 B/D to 100 B/D
3. Ventura, California. Newest world record McCullough Gun Perforating job. 7620 Burrless Bullets shot with McCullough 90-shot Gun Perforator in 81½ hours!	Very satisfactory (Actual figures not released)
4. Cyril, Oklahoma. Open hole and through 7" casing. Formerly perforated obtaining 210 B/D. McCullough Glass Jet Perforator shot 600 holes around 6,000 feet. Time on job—11 hours.	210 B/D to 676 B/D
5. Eunice, New Mexico. Casing size: 5½"—17 lb., lime formation. New Well. McCullough Glass Jet Perforator shot 312 holes in 100 foot interval around 8,000 feet. Time on job—7 hours.	0 B/D to 1520 B/D
6. Ventura, California. Squeeze job. McCullough 3" Glass Jet Perforator. Casing size: 11¾", 20", set in 26" hole. Total of 7" penetration necessary. through 1" of steel and 6" of cement, mud and formation.	Satisfactory Squeeze job

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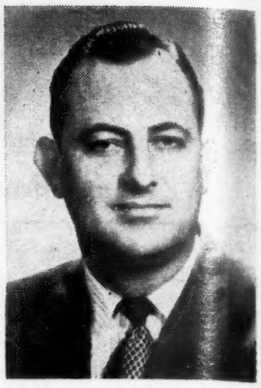
John Ed Cooper

C. L. Glass

Walter Beadle

John F. Younger



R. E. Cox

John Ed Cooper has been named senior vice president and general sales manager of The Western Company, oil well acidizing perforating company, Midland, Texas. Other vice presidents recently named are: **C. L. Glass,** financial vice president and secretary; **Walter Beadle,** vice president of acidizing and allied services division; **John F. Younger,** vice president of wire line services division, and **W. M. Osborn,** vice president and geological advisor. **R. E. Cox** was named treasurer and assistant secretary.

Cooper joined the company as sales manager of Western in 1945. Glass became office manager of Western in 1945 when the company offices were at Seagraves. In 1948, he was appointed secretary-treasurer of the company. Beadle joined Western 8 years ago as manager of its Eunice, New Mexico, acidizing station. He later became district manager at the district office in Odessa and in 1948 was made manager of the acidizing department. Younger became manager of Western's perforating department in 1947 and initiated the service. In his new position he will direct the activities of Western's bullet and jet perforating service, perforating research and development laboratory and all services that require the use of a wire line.

In his capacity as vice president and geological advisor, Osborn will act as consultant for Western's Geological Section. He was a consulting geologist before joining The Western Company 8 years ago. Cox joined Western's accounting staff in 1946. In 1948, he was promoted to comptroller and in 1950 was made assistant secretary-treasurer.

William D. Davis has been named head of the geological department of Stanford Oil Company. Davis, who will operate from the company's field office at Evansville, Indiana, was geologist for the Standard Oil Company of Ohio for many years. He is secretary of the Tri-States Geologists Association and is one of the group, which in recent years developed the rich Tri-State Oil Basin in Illinois, Indiana, and Kentucky.

W. H. Newman has been promoted from marine drilling tools supervisor in Magnolia's Louisiana-Gulf Division to assistant drilling tools superintendent of the Gulf Coast Division.

B. O. Smith, supervisor of industrial relations, West Texas division, producing department, The Texas Company, has been promoted to the office of L. J. Whetsell, assistant to manager (industrial relations), producing department, and transferred from Fort Worth to Houston, Texas. He succeeds **Joe A. Hale,** who has been assigned to handling land matters for the manager's office.

Smith joined The Texas Company at Breckenridge, Texas, in 1934 and, after holding various positions, was advanced to supervisor of industrial relations, West Texas division, in 1944.

E. E. Callaway, assistant supervisor of industrial relations, South Texas division, will succeed Smith as supervisor of industrial relations, West Texas division. He was employed by the company at Wichita Falls in 1930. After various jobs, he was made a safety engineer and assigned to the east coast and later Texas and New Mexico zone.

M. C. Pitts, Texaco safety engineer with headquarters in Atlanta, Georgia, has been named to replace Callaway as assistant supervisor of industrial relations, South Texas division.

E. L. McIntyre, safety engineer with headquarters at Fort Worth, will be transferred to the newly-created job of assistant supervisor of industrial relations in Callaway's office at Fort Worth, Texas.

Norman Hardy has been elected a vice president of the Arabian American Oil Company. Hardy began his oil career in 1926 as a geologist with the Standard Oil Company of California. He has worked in Indonesia, Holland and South America as well as in the United States. Prior to joining Aramco last February, Hardy was president of the Richmond Petroleum Corporation, a subsidiary of Standard Oil of California. His post will be in Dhahran, Saudi Arabia, field headquarters for Aramco.

O. R. Gammon is party chief of a new Sun Oil Company gravity crew assigned to do special survey work from headquarters in Altus, Oklahoma. **William Guest,** former Sun Oil Company seismograph party chief, has been transferred to the company's Beaumont, Texas, staff as a field superintendent.

Laurence A. Sunkel of Dallas, general manager of domestic crude oil production for The Atlantic Refining Company, has been elected a director and a member of the executive committee of the Texas Mid-Continent Oil and Gas Association.

Sunkel will succeed **E. H. Blum,** Dallas, Atlantic vice president and general manager of crude oil production, who is retiring.

In his new capacity, Sunkel will also serve as a director in representing the Texas Mid-Continent on the board of the General Mid-Continent Oil and Gas Association.

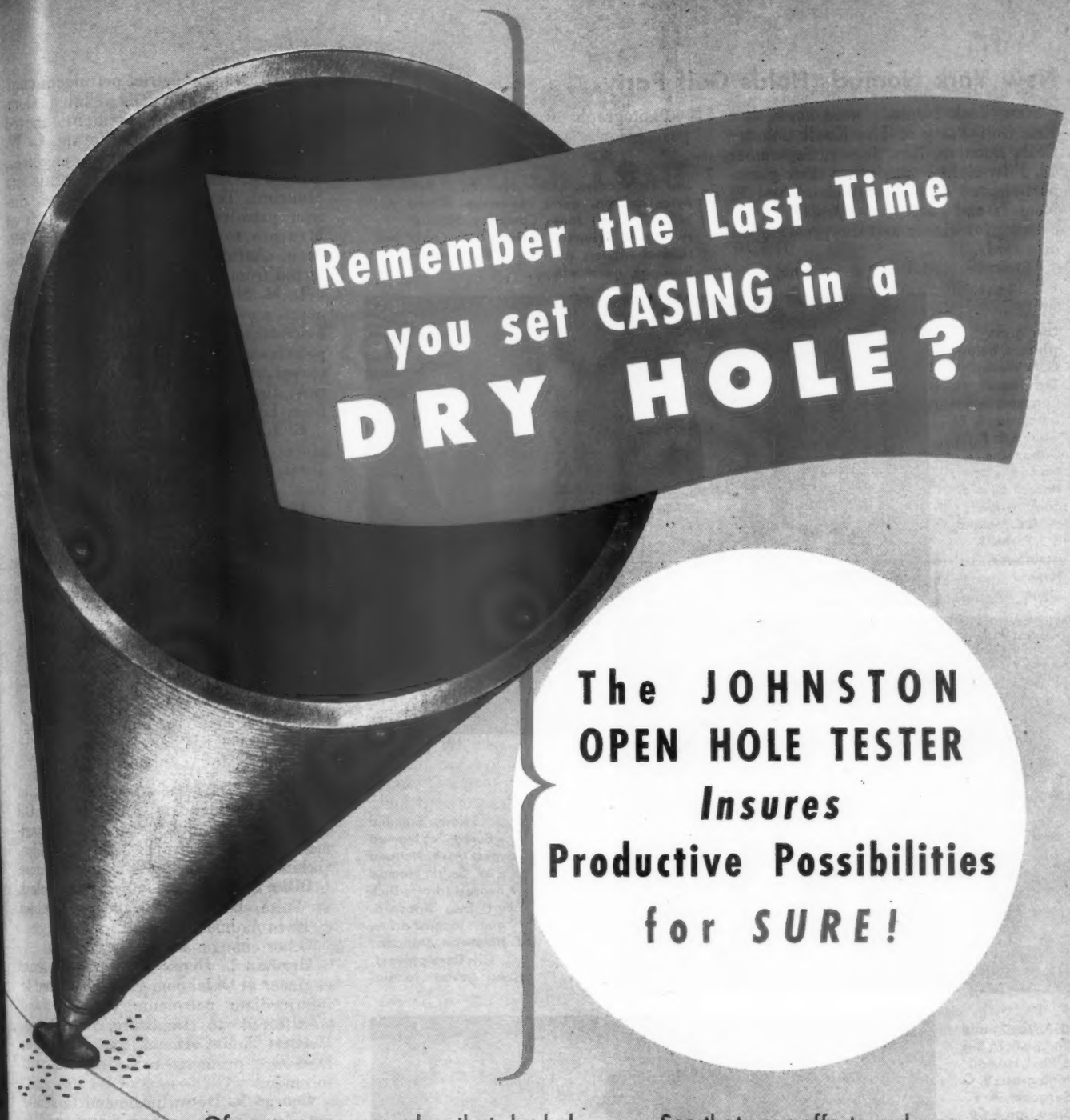
H. R. Shannon

H. R. Shannon, Oklahoma City, has been named production superintendent for The Carter Oil Company's northwest division. He will have his headquarters in Denver, Colorado. A Carter employee for 26 years, Shannon has been in charge of operations in Oklahoma and Kansas the last four years and previously handled Carter production operations in Montana and Wyoming.

Roger S. Frazier, Oklahoma City, will be division petroleum engineer for Carter's Northwest division, with headquarters also in Denver. Frazier began service with Carter in 1938 on graduation from University of Michigan.

Replacing Shannon is **J. L. Rogers** as central division superintendent. He has been with Carter since 1935.

H. L. Spillers, Seminole, Carter district superintendent, becomes assistant division superintendent in Oklahoma City and **R. B. Chapman,** Tulsa, has been named assistant division engineer in Oklahoma City succeeding Frazier.



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FORMATION AND CASING TESTING — JOHNSTON

New York Nomads Holds Golf Party

New York Nomads were hosts to a Fall Golf Party at The Knoll Country Club, Boonton, New Jersey, September 18. Fifty-eight Nomads and their guests participated in the tournament and 70 Nomads and guests were present in the evening for dinner and the presentation of awards.

Photographs of the day's winners appear below.

Low net winners, below: Normán D. Jesse, Byron-Jackson, guest runner-up; Alfred A. Binkerd, S. M. Jones Company, Nomad runner-up; Joseph B. Roberts, Jr., Chain Belt, Nomad winner; William B. Ashland, Dalc Bearings, guest winner.

Low gross winners, below. G. R. Weeks, The Texas Company, guest runner-up; E. F. Gahan, E. F. Gahan, Inc., Nomad winner; Harold Busold, guest winner; Herb E. Maland, R. J. Eiche & Associates, Nomad runner-up.

Below, Edmund Burke, Jr., Nomad longest drive; Holland W. Smith, Nomad nearest to pin; Dick Burt, Esso Standard, guest longest drive; L. L. Horstman, Standard Oil Development, guest nearest to pin.

C. P. MacDonald, Parkersburg Rig & Reel, Nomad high gross; B. C. Sergeant, A. V. Simonson & Co. and Lufkin F&M, guest high gross; John Flahie, Creole, Venezuela, guest fewest putts, Russell D. Heath, Russell & Stoll Co., Nomad fewest putts.

H. B. Barton, district petroleum engineer, Humble Oil and Refining Company, producing department, moved from Friendswood to California. **C. W. Armstrong,** district petroleum engineer, was transferred from California to Maurbro, Texas. **J. P. McAdams,** district petroleum engineer, moved from Maurbro to North Katy. **J. H. Wellborn,** district petroleum engineer, transferred from North Katy to Galveston.

L. M. Sloan, district petroleum engineer, moved from Raccoon Bend to Friendswood. **L. M. Duhon, Jr.,** district petroleum engineer, at Sugar Valley moved to Raccoon Bend. **R. E. Kilpatrick,** district petroleum engineer, moved from Lovell Lake to Sugar Valley.

E. J. Anderson, senior petroleum engineer, Galveston Bay, was promoted to district petroleum engineer at Livingston.

J. W. Smith, petroleum engineer, Galveston Bay, was named district petroleum engineer at Livingston.

J. B. Bower, district petroleum engineer at Livingston moved to California as farm boss.

W. W. Denyer, farm boss at Galveston Bay, was promoted to assistant district superintendent at Anahuac. **Guardie Kretzschmar,** farm boss, moved from Friendswood to Galveston Bay.

John H. Pittman, district civil engineer, from Houston construction division moved to Anahuac district.

Ralph W. Newport, senior clerk at Ardmore, Oklahoma for Sinclair Oil and Gas Company, production department, has been transferred to Tulsa, Oklahoma. Replacing him at Ardmore is **Billie B. Brogdon,** intermediate clerk at Tulsa. Brogdon will become senior clerk in Ardmore.

Other changes include:

Herman L. Hensel, junior petroleum engineer at Oklahoma City, promoted to intermediate petroleum engineer and transferred to Delaware, Oklahoma. **Herbert T. McCormack,** gas foreman at Delaware, promoted to assistant district foreman.

George V. Dunn, promoted to senior petroleum engineer and transferred to Seminole from Lindsay where he was intermediate petroleum engineer. **George Platt,** intermediate petroleum engineer at Kiefer, transferred to Tulsa. **Ollie W. White,** senior clerk at Delaware, reclassified as warehouseman. **Walter W. Armor,** senior clerk at Chase, Kansas transferred to Delaware.

W. H. Upton, district foreman at Alma, transferred to Kiefer. **Wyatt L. Sisson,** district foreman at Kiefer, transferred to Alma, and **Elmer L. Mikeman,** gang pusher at Drumright, promoted to construction foreman.

John E. Phillips, Marion, Kansas, has joined Deep Rock Oil Corporation as area landman for the Wichita, Kansas, office. Phillips attended Kemper Military school and received his B.S. degree in business administration from the University of Colorado.

He was employed by Stanolind for three years before joining Deep Rock.

From Oil and Gas Come 400,000 Tons Sulfur a Year

ARCH L. FOSTER*

With the world running short of sulfur by a million long tons annually, any source of this barometric industrial material is an important source. For sulfur is considered the barometer for industrial development and activity the world over; the amount of sulfur consumed in its various forms is taken universally as the index of the industrial activity of a district or country. Of course sulfuric acid is the form in which the huge major portion of sulfur is consumed.

And according to data given herewith, it appears that the oil and gas industry, within the twelve month will be making up nearly half that deficit. Determined by the best information available at the instant, some 400,000 long tons of elementary sulfur will be recovered each year by these industries, when all capacity now under construction or plan, or already in operation is producing at rated capacity. Nor is this figure the maximum that the oil and gas industries could produce if a crisis demanded greater output. Large amounts of hydrogen sulfide-bearing gas are produced, or are available for sulfide extraction if and when the demands make it economically sound operation to recover the sulfur. Large quantities of hydrogen sulfide are removed from natural gas or refinery gases and blown to the atmosphere or more generally burned under boilers, stills, or in flares that can be recovered if need be.

The current sulfur shortage is caused by a great number of factors. Due to war and the aftermath of war, sulfur is not produced abroad in quantity sufficient to supply world demands outside the United States, consequently we must make up the world sulfur deficit just as we are making up a large part of the world's "dollar deficit," by contributions from our own store. Industrial development in general was delayed by the war, existing facilities destroyed, all of which accentuated the rush to rehabilitate and expand facilities as soon as the war was over. Our own national situation became critical rapidly, in the face of widespread expansion of chemical and allied industries in which sulfuric acid and other sulfur forms require huge amounts of "brimstone" both as components of the finished products and as agents in carrying out innumerable reactions to make a host of products.

*Editor, Refining and Gas Processing.

As the result of all this, at least 13 oil and gas company units are operating or are under construction or design, with large activities being carried out by sulfur companies. These oil company units are rated at from 10 long tons to 120 tons daily, according to published figures, or a total daily output of nearly 1100 long tons. Assuming 350 operating days per year—which may or may not be over-optimistic — this shows about 390,000 long tons to be derived from this source alone, to whittle down the deficit.

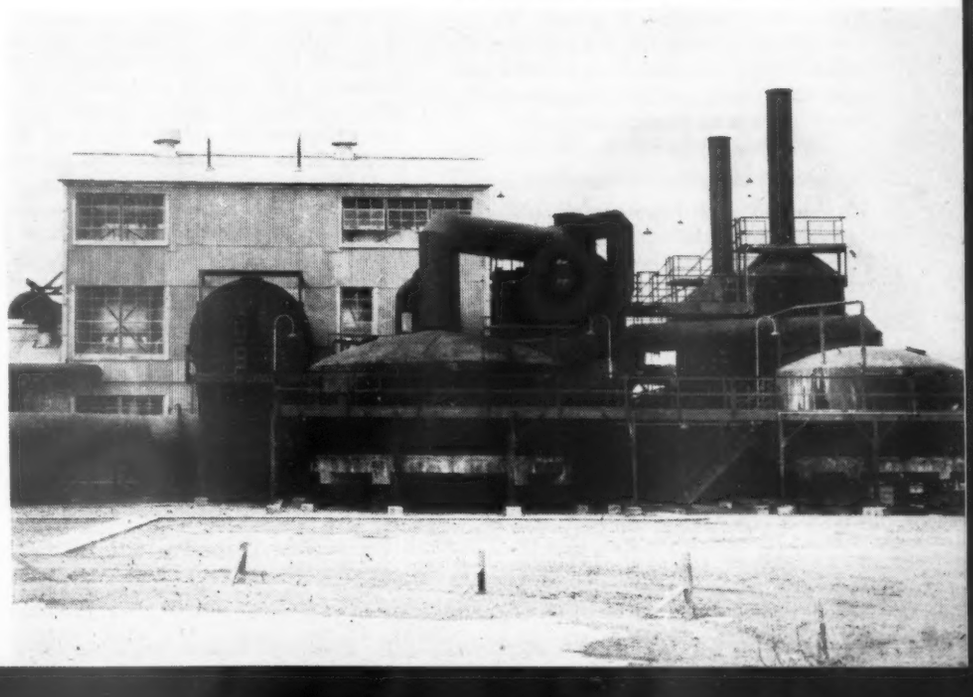
Nor are the oil companies the only industrialists attacking the problem with successful results. Included in these oil-and-gas figures is the huge plant at Worland, Wyoming, where Foster Wheeler completed recently a 300-ton-per-day unit for Texas Gulf Sulphur Company now going full blast. And the largest "find" of all is that of The Texas Company, which completed a contract a short time ago with Freeport Sulphur Company whereby the latter is to develop deposits in the Mississippi Delta area, at Garden Island salt dome at the mouth of 'Ole Miss', to produce 500,000 long tons of sulfur annually, the largest development in sulfur in 20 years. This production, expected to be in full swing by 1953, will take care of about half the present world deficit. According to the announced terms of the contract Freeport will return to Texas Company 50 per cent of the profits of the venture. When this production boost is combined with the increase of 530,000 tons expected from the operation of three new mines, which began development recently by private capital, two years should see the world with a surplus of sulfur for the first time since before the start of World War II.

Reference to the tabulated data on sulfur production shows the rapid rise in U. S. output since 1945-46, which obviously is keeping pace with world development in all or most industrial expansion. Those acquainted with conditions say that this country is producing enough sulfur for its own requirements, but that the necessity for supplying sulfur to foreign countries is creating the deficit and this in turn is traceable to the failure of the world outside the U. S. to supply its own needs. What will follow this period, if the rest of the world develops sulfur production to meet its consumption within a reasonable time will have a strong effect, doubtless, on the American sulfur picture.

For the recovery of sulfur from petroleum and natural gases two major processes are in operation. These processes employ the same general principles but differ in various details, arriving at the same point. One process is licensed by Foster Wheeler Corporation and the other is licensed by Fluor Corporation under Mathieson Chemical patents.

The first step in any process is the concentration of the hydrogen sulfide from refinery or natural gases by some acceptable means, and most plants at present utilize the principle of absorption in a suitable medium, followed by separation from that medium by appropriate methods after removal from the main body of hydrocarbon gases. In the Girbotol process, the raw gas is bubbled through a water solution of monoethanolamine, a "loose" chemical

Texas Gulf Sulphur Company's sulfur recovery unit at Worland, Wyoming recovers 300 long tons a day from sour natural gas.



union between the amine and the sulfide being effected at essentially atmospheric temperature. This solution is removed from the contact tower and is heated in a separating tower. At elevated temperatures the loosely-joined amine sulfide compound is unstable and hydrogen sulfide is released in gaseous form along with any carbon dioxide, which was also present in the raw gas and which is absorbed also by the amine solution. This step is employed widely in the gas and refining industries to eliminate sulfide whether or not it is used for any useful purpose or is burned in a flare.

Vapors leaving the sulfide removal tower, high in hydrogen sulfide concentration and containing varying amounts of carbon dioxide, are mixed with a carefully calculated amount of air, to supply oxygen. By heating the mixture of oxygen (air) and sulfide gas a portion of the sulfide is oxidized to sulfur dioxide according to the following equation;

$$2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$$

Sulfur Dioxide

The carbon dioxide present is an inert, and has no part in the recovery of the sulfur.

The sulfur dioxide formed is regulated in quantity to satisfy quantitatively the following equation, in which this SO_2 reacts with the remaining hydrogen sulfide;

$$2H_2S + SO_2 \rightarrow 3S + 2H_2O$$

This elementary sulfur is in vapor or liquid form and is maintained as a vapor or liquid when being washed to remove impurities formed during the reactions. It is relayed finally to solidifying vats or containers where it is allowed to cool and is handled further as a solid. The amount of sulfur dioxide formed must satisfy the second equation. From this equation we see that about 64 lb of SO_2 react with 68 lb of hydrogen sulfide; therefore the final reaction mixture, after Step 1, must contain the two vapors in these proportions. From the equation for Step 1 it is noted that when burned with oxygen of the air admitted prior to that step, 34 lb of sulfide, or one pound-mol yields 64 lb, or one pound-mol of dioxide. Therefore, one-third the hydrogen sulfide must be oxidized to the dioxide in order to convert the whole sulfur content of the vapor stream to elementary sulfur.

The number of uses for this sulfur is legion. Oxidized to sulfuric acid it is a part of or a reagent in numberless chemical and other processes. One of its largest uses in the petroleum industry is as a catalyst in the alkylation of isoparaffins with olefins to produce alkylate, a most important, high octane rating ingredient of aviation fuels for the conventional piston-type reciprocating airplane engine. For economic reasons for the process unit, as well as to aid in meeting sulfur demands overall, large expenditures are made for the recovery of the sulfur in this acid, and the spent acid is burned again to recover sulfur dioxide to carry through the process for making the acid from this SO_2. For a half a century and more sulfuric acid has been employed in huge quantities as a purifying (treating) agent in refining petroleum refinery products, especially thermally cracked distillates, burning oil and lubricating oil stocks to yield acceptable finished products.

More recently large amounts of sulfuric acid are employed in the synthesis of various petroleum products such as sulfonates and become a part of the final product, thus cannot be regenerated for reuse in industry. These sulfonates are combinations of hydrocarbons (usually olefins or, in some cases, aromatics) with the acid, combined with the elimination of a molecule of water.

The type formula is essentially (Alkyl such as C_2H_5) $-SO_3H$, with which may be combined a metal ion or other positive ion to form the sulfonate of commerce. These sulfonates are employed in huge quantities in detergents, additives for various purposes, and in other commercial and industrial products. Elementary sulfur has been employed in the vulcanization of natural and of synthetic rubber since the discovery of the vulcanization reaction, and its requirement for that purpose is growing also by leaps and bounds, with no recovery angle to lessen the drain on supplies.

The list of sulfur recovery projects shown in the accompanying table by no means exhausts the possibilities of the oil and gas industries. Great quantities of hydrogen sulfide are found in West Texas fields, only a small portion of which will be recovered by these units. The gas being burned in the Texas Panhandle to make the tremendous quantities of carbon black is all "sour" gas, containing sulfide in amounts too high to permit the gas to be used as "pipe line" gas, according to present practices. Various desulfurization units are being installed on feeding systems for gas lines, and the sulfide so removed may be converted to sulfur in the same manner if and when prices, demands, and the concentration of sulfide make the recovery feasible economically. Elsewhere in Texas, Kansas, Oklahoma, California and the mountain states Montana, Wyoming, almost incalculable amounts of sulfur are obtainable, economics ruling the decision as to whether it shall be recovered; the main factor in this economic question is the concentration of sulfur and the cost of its isolation.

Obviously the major increases in sulfur recovery will come from such finds as the Garden Island deposit under development by Freeport Sulphur. The Texas coastal area has a large number of so-called salt dome formations, in which in many cases huge deposits are found, and by no means of processes already perfected this sulfur is melted and brought to the surface to augment our supplies.

As a consequence of these exploratory activities and the installations to recover oil and gas sulfur made recently, the total prospect for increase in sulfur production within the next two years appears to be of the order of 1,500,000 long tons per year, more than enough to make up our present deficit. Normally, the construction of a unit to recover sulfur from natural and refinery gases requires less equipment and a shorter time to go on stream than in the case of underground deposits that require heavy drilling operations and the installation of large amounts of piping, heating facilities, and auxiliary equipment before operations can start. One underground producing unit will, however, bring to the surface many times the amount of sulfur that any one oil or gas unit can recover. In any event, it now appears that, while a pinch is on in world industry at present within two years or so we may expect adequate supplies of this all-important element to be made available for all purposes. * * *

Oil and gas industry sulfur recovery units.

Company	Plant location; county	Daily capacity, long tons	To be completed	Builder
Sid Richardson Gasoline	Winkler, Texas	25	Late 1951	Graff Eng
Phillips Petroleum	Goldsmith, Texas	120	Late 1951	Ralph Parsons
Standard Oil (Indiana)	Whiting, Indiana	55	Mid-1952	Fluor Corp.
Consolidated Chemical Industries	Baton Rouge, Louisiana	50	. . .	Parsons
Southern Acid and Sulphur	McKamie, Arkansas.	100	1944	Foster Wheeler
Southern Acid and Sulphur	Magnolia, Arkansas	60	1945	Foster Wheeler
Texas Gulf Sulphur	Worland, Wyoming	300	1949	Foster Wheeler
U. S. Army Ordnance	Morgantown, West Virginia	25	1949	Foster Wheeler
Royalite Oil, Ltd.	Alberta, Canada	30	1952	Foster Wheeler
Esso Petroleum, Ltd.	Fawley, England	40	1952	Foster Wheeler
Continental Sulphur and Phosphate	Cody, Wyoming	?	?	Chem. Constr. Co.
Lion Oil	Magnolia, Arkansas	10	1952	Graff Eng.
Shell Oil	Alberta, Canada	30	1952	.....
Shell Oil	Stanlow, England	10,000 (per year)	Late 1952	.....
Shell Chemical	Houston, Texas	50 (13,000 per yr.)	1952	Ralph Parsons
Sinclair Refining	Marcus Hook, Pennsylvania	20	1952	Ralph Parsons
Gulf Oil	Port Arthur, Texas	50	1952	Ralph Parsons
Hancock Chemical	Los Angeles, California	50	1950	Badger and Sons
Stanolind Oil and Gas	Elk Basin, Wyoming	70	....	Stone and Webster

(Other projects are under consideration but not announced so far as is known with certainty).

Production and shipment of sulfur in the U. S. A., 1942-51.

Year	Long tons shipped	Long tons produced
1942	3,128,559	3,460,686
1943	2,953,845	2,538,789
1944	3,519,083	3,218,158
1945	3,833,294	3,753,188
1946	4,128,212	3,859,642
1947	4,828,103	4,441,214
1948	4,978,912	4,869,210
1949	4,789,311	4,745,014
1950	4,780,184(approx.)	5,342,184
1951(1st. half)	.....	2,690,000

Source: U. S. Bureau of Mines.

An overall picture of a gasoline plant. Note relative location of equipment. Plant has symmetrical arrangement and room for both maintenance and expansion. Note the small shelters for locally grouped instrumentation.

DESIGN OF GASOLINE PLANTS

PART 2—EQUIPMENT AND UNIT LAYOUT

O. L. LEWIS*

PLANT location is generally considered a management function. Availability and cost of suitable sites must be investigated. Proximity to source of charge stock and point of sale is important. Only after a suitable site has been chosen does plant design come into the picture. Equipment location within the plant is a design function. The design must carry out the general plan established by basic plant layout.

In layout of a complete plant break it down into areas and establish the geographical relationship of these areas. Unit areas usually found are (1) compressor plant, (2) process area, (3) storage area, (4) utilities.

*C. F. Braun and Company.

Compressor Station Layout

One question to come up is: Do the compressors set crosswise in the building as in Fig. 1 or lengthwise as in Fig. 2?

There is a place for each arrangement. An installation where all cylinders have the same suction and discharge pressure, single stage operation will probably be more economical when arranged with compressors across the building as shown in Fig. 1. Actually most gas plants have more than one stage of compression so this arrangement is really more applicable to pipe line station installations.

EXCLUSIVE

In a gasoline or recycling plant compressor station several different pressures are required. When it is necessary to pipe two or more stages to the same compressor the Fig. 2 arrangement will be the most economical both in floor space required and cost of piping.

Elevation of building. As compressor plants have been growing in size, one of the favorite points of argument is the question of elevation. Not too many years ago the compressor building floor was set 6 in. above grade and the piping ran out buried under the floor. That was simple. That was cheap. It was cheap but not economical. Leaks were hard to find. Cor-

FIG. 1.

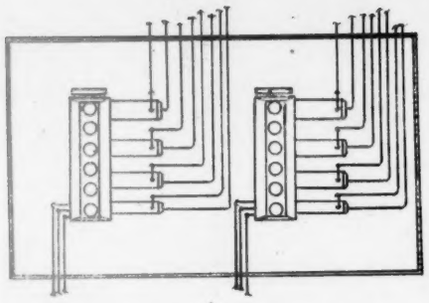
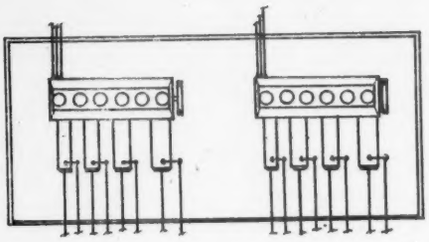


FIG. 2.



get to for maintenance. The basement is a trap for any heavier-than-air gases that might accumulate. It is a trap for operators in case of accident. Perhaps the most conclusive argument against the basement compressor station in gasoline plants is cost.

Two plants of comparable size, built in the same year under similar conditions, show that the basement type installation was approximately

rosion hard to prevent. Piping repair almost impossible.

Then some smart construction man found out he could run the piping out overhead and drop onto piers cheaper than he could put in underground piping. That was fine for most installations of the old, low speed compressors. The problem was whipped.

Just when everyone was happy, along came the new, high speed compressors. Higher working pressures came into the picture. A few tried to use the same old installation only to find that vibration had reared its ugly head. Pulsating piping just doesn't like high places. Well, it was brought back down to earth. Several ways of doing this without burying the pipe were worked out.

1. Leave the compressor floor just above grade, bring the lateral piping out in trenches and up into the bottoms of outside headers supported on concrete piers. Fig. 3. This is fine but a lot of trench is required that is expensive to build, hard to keep clean, and difficult to drain.

2. Raise the elevation of the compressors and the building enough to allow the laterals to come out below the floor and high enough above grade outside to go into the top of the headers. This works fine with small piping. It puts the compressors and building on stilts when the laterals are large. Fig. 4.

3. Raise the compressors and building just enough for the laterals to come out below the floor and just above grade. Raise the headers a little higher on piers and let the laterals go up into the headers. This arrangement in general is the most economical to build and the easiest to maintain. Fig. 5.

Some pipe line compressor stations were built with a basement under the building. This seemed a fine plan for water pumps, oil coolers, oil filters, etc. This was a wonderful idea for pipe line stations. Especially in areas of severe weather where auxiliary equipment should be housed. It is not too applicable to gasoline plant stations. Basement equipment is hard to

FIG. 3.

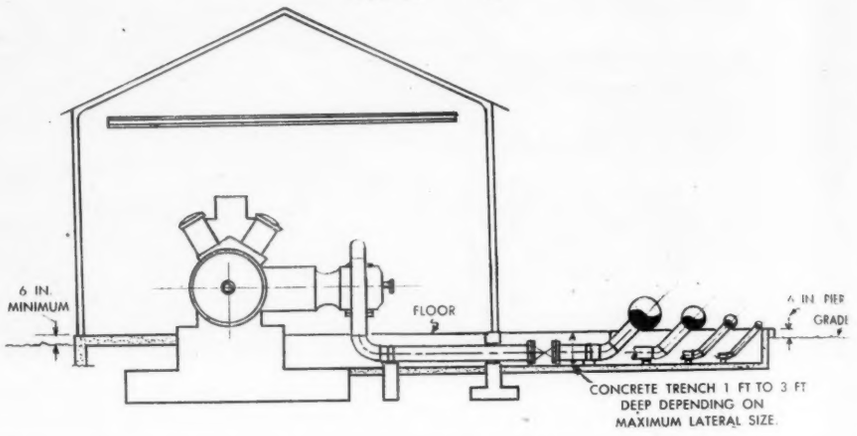


FIG. 4.

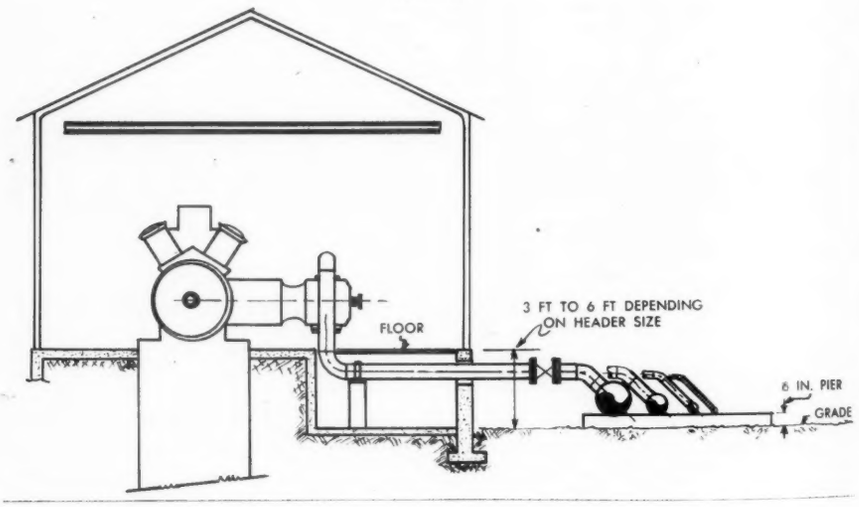
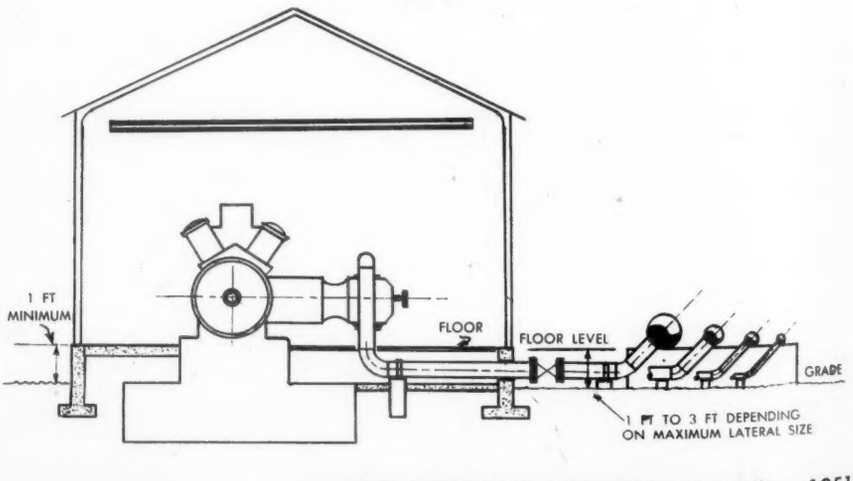


FIG. 5.



A typical modern gasoline plant compressor installation. The high cylinder cooling water return header was lowered after this picture was taken. The installation was then much better looking and piping vibration was reduced.

$35,000 more expensive to construct. Is it worth it?

Access and maintenance. Anyone can lay out a compressor plant that will do the job. Now look at some of the things that make the difference between a good one and a bad one.

One of the worst faults is cramped space in the building. The compressor supplier protects us some by recommending an adequate spacing of the units themselves. That recommended spacing is for a standard unit. If belt-driven water pumps, oil cleaners, or other auxiliary equipment are situated between the engines more room is needed. The spacing should be increased to allow a minimum net clearance equal to the manufacturer's recommendation. The operator or maintenance man will need that space someday. On a unit of 600 hp or more about 6 ft is a minimum. Eight feet is much better.

Now how about space in front of and behind the units? Room for a man to walk around the unit isn't enough. He has to work around it, too. He has to work with big pieces of heavy machinery. Leave him a minimum of 6 ft clear behind the engine and 6 ft clear in front of the cylinders. Both figures are outside of all piping or obstruction.

Adequate room in a compressor building not only is an aid to operation and maintenance but it is the difference between a crowded, cheap looking plant, and an attractive, economical plant.

A trolley and hoist is needed to handle both engine and compressor cylinders and pistons. On smaller engines it is theoretically possible for a man to handle the engine piston without a hoist. Actually an engine is rarely worked on without a hoist of some kind. If a trolley and rail is not provided for it, then temporary rigging is set up. This is both dangerous and expensive. Trolley rail is a lot cheaper than accidents. When two rails are provided, one over the engine cylinders, one over the compressor cylinders, a U connecting them at one end will be a big help in moving the trolley and hoist from one rail to the other. If a U is placed at both ends, handling is again simplified. It is so much easier to get the hoist from the engine to the compressor end of the unit.

It does no good to provide adequate space in the building and adequate trolley and rail unless you can get the equipment away from the building after it is removed from the unit. At least one end of the building should always be clear. A truckway should be provided to double doors in the end of the building. If both ends can be reached by truck, so much the better. Usually one end of the building is pretty well fixed, at the other it is necessary to plan for future expansion. Be sure that reasonable access is still present for the expanded plant.

We have talked about the units and what is required in the way of space and layout to operate and maintain them. Now think about convenience of personnel and operation. Doors and walkways must be provided for access to the building. They should be placed properly for convenience and safety. The operator must be able to get out of the building for maintenance of air cleaners and for operation of valves. Usually one door should be provided for each unit. If doors and walkways are approximately centered on the space between units, it is easier to get to the doors from any point in case of emergency. The doors should not be placed exactly opposite. A better plan is to stagger them—on the engine side at one space, on the header side at the next. With this arrangement a person is never more than the length of one unit from a door.

Using an elevated compressor building, the walkways should be level with the building floor. Steps right at the door are dangerous. If a person is running from an accident he is much less likely to stumble on steps at the end of the walk away from the building than he is if steps are right at the door.

Process Area Layout

Location of pumps. Several plans of pump location are used in different plants. The climate and conditions of operation are important in deciding which to use.

Three of the most common pump layouts are (1) situated individually adjacent to source of suction, (2) situated in a pump row either just in front of or just behind vessel row, or (3) centrally placed in a pump house.

Locally mounted pumps adjacent to source of suction are probably the most economical from a construction standpoint. Less process pipe is required. Sometimes fewer fittings are needed. The larger suction lines do not require as much support. Many times additional valves can be saved. These things all save on original cost. The shorter, more direct suction lines insure a low pressure drop for the pump suction.

All sounds good, doesn't it? There are two sides to every story, however. It is hard to make a good looking plant with this arrangement. Difficulty is encountered in providing room for access to the pumps. Many times the pump would be where nothing larger than a wheelbarrow could get to it. Drain lines will be longer and more complex. Steam lines or electric power leads will be more complex and expensive. The operator has farther to walk each time he goes around to check pumps. In case of a pump fire, it is closer to the tank and there is more danger of extensive damage. The pump and its driver are exposed to the

weather constantly. Upkeep and maintenance will be costly. Any pump repairs will have to be made in the open or portable shelter provided.

Thinking of these disadvantages, think of locating all pumps in a central pump house.

The machinery is protected from the weather. Maintenance is low and convenient. The pumps are grouped and operation can be checked conveniently and in out of the cold. Steam headers are short and convenient for piping. Power leads and drain system are economical to install but are under the concrete floor and hard to get at if necessary. A pump house can really be a thing of beauty and is a high point in many plants. One end of the building can be left unobstructed so that truck access is convenient. An overhead trolley rail is cheap and a big time saver.

This is all fine but some things are given up, too. Suction lines will be long and hard to lay out without pockets. Added fittings will be expected and suction pressure drop goes up. A larger suction line or higher accumulator may be required. A pump remote from operating vessels is at times an operating inconvenience. At times one man will be required at the pump, another at the accumulator checking level or pressure. Most plants will have both a valve at the accumulator and another at the pump. The building costs extra. Lines are hard to support and guide properly. All in all, a very expensive installation to install but one that is comfortable to operate, pleasing to look at, and easy to maintain.

The outside pump row as used in many plants now, evolved as a partial answer to some of the objections to both of the preceding arrangements. This layout is symmetrical and pleasing. Pumps are close enough to operating vessels so that each system can be operated locally. Suction lines are reasonably short and straight. Pumps are easy to get to for maintenance. Steam piping is short and economical. Steam headers are economically supported on the major pipe lanes. If electric motors are used, the power leads are direct and economical. The operator can see all vessels and pumps from one aisleway. Drain system is economical.

Yes, there are some remaining objections. The pumps and drivers are still exposed to the weather. Minor repairs must be made in the open. Suction lines are not as short as those for locally mounted pumps.

In general, the advantages of both other arrangements are retained except for weather protection. Convenience of operation is assured. Maintenance is not difficult. Construction and original installation cost is economical.

The last plan of using an outside pump row is preferred in nearly all modern plants. Exceptions are where extreme climatic conditions are present or in instances where pump suction conditions are extremely critical.

Towers and tanks are the big items of equipment. All other equipment is located relative to them. Probably the most critical point to keep in mind is space requirement. Maintenance, possible removal of equipment, access for servicing treater towers, room for proper piping, aisles and operating walkways all require added space between equipment. A good layout not only takes these points into consideration but still keeps the unit compact enough for operating convenience.

Custom decrees that most vertical towers and vessels be lined up. Sometimes one, sometimes two or more rows of equipment are required. In a normal size plant one row on each side of a central pipe lane is very economical and convenient from operating and maintenance standpoints.

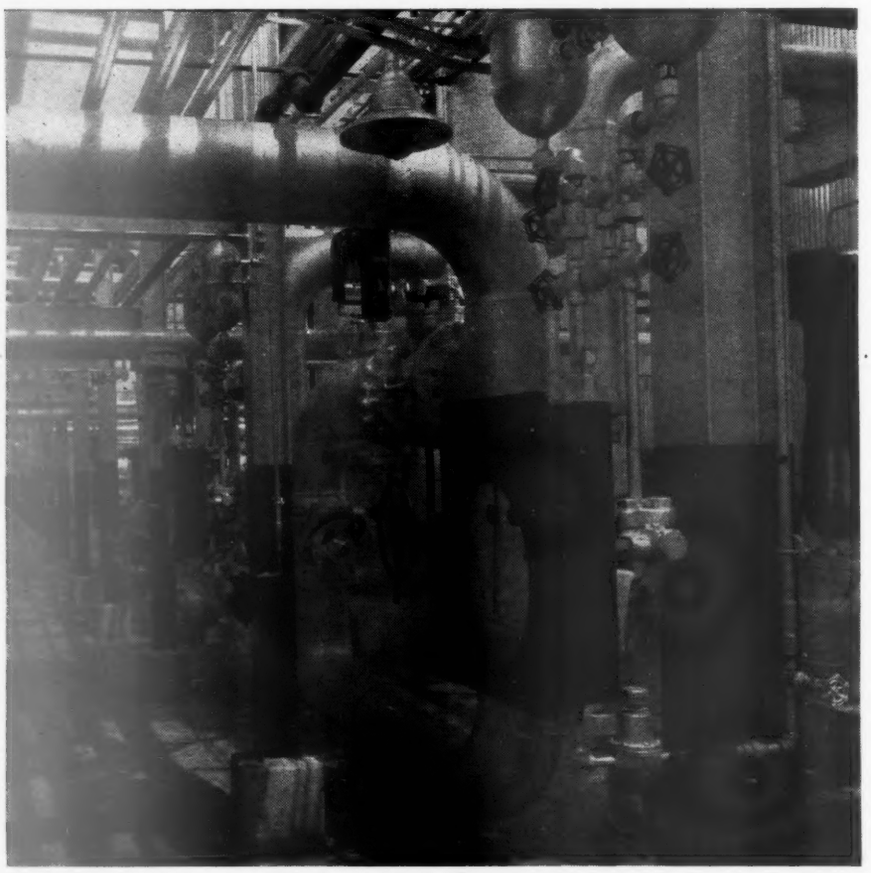
The order of towers should be established by process flow. Then an operator can walk directly down an aisle and follow the various steps in operation without back-tracking. If possible at least 6 ft of clear space should be left between adjacent columns. Many times more room will be required for piping. Simple towers, such as absorbers, with few overhead lines will usually be satisfactory at a minimum spacing. Stills and similar columns require more room for piping. No less than 8 ft and usually 10 ft will be required between the columns.

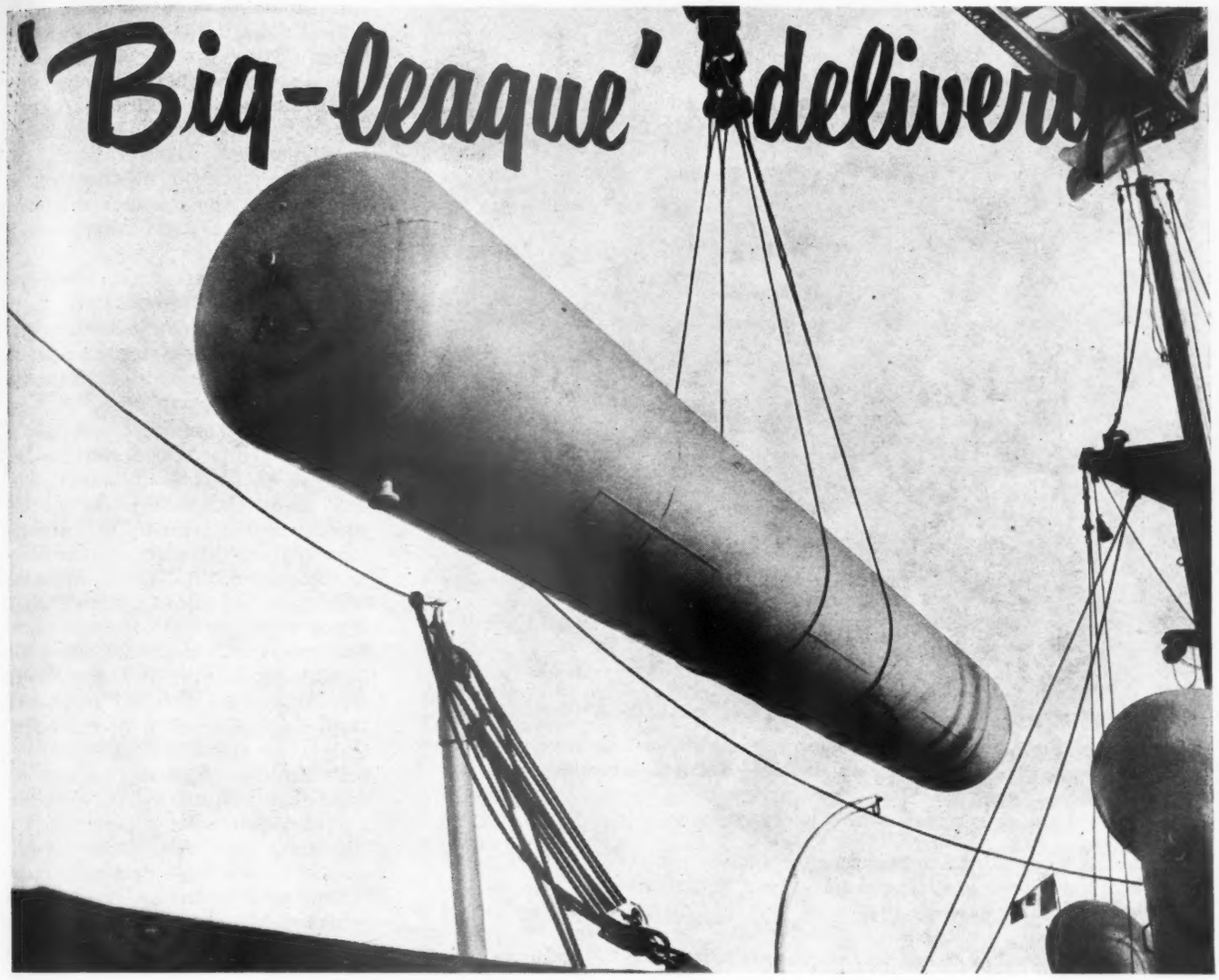
Of course, these minimum requirements do not necessarily set final spacing. They are a starting point.

Usually horizontal tanks and accumulators will be in another line directly behind the columns. Exchangers should be grouped with the horizontal vessels. Here again, operating and maintenance space must be allowed. Actually the horizontal equipment normally will set tower spacing. This is because several items of horizontal equipment are required for each tower. The accumulators, pumps and exchangers should be grouped around the tower with which they operate. This arrangement adds operating convenience and makes piping economical.

In a small plant it may be desirable to line up the front head of accumula-

Here is an excellent arrangement of control valves and locally mounted instruments.





● It is easy to understand why it took more than a rigger's version of "Geronimo" to set this giant propane tank "paratrooper"—and five more like it—snug aboard the S.S. Paolina . . . its 70′10″ length would cover a strip on a big-league diamond from pitcher's slab to the end of the catcher's box, 10 feet behind the plate. Its 103″ I.D. would allow a pitcher's full stretch . . . a batter's full swing.

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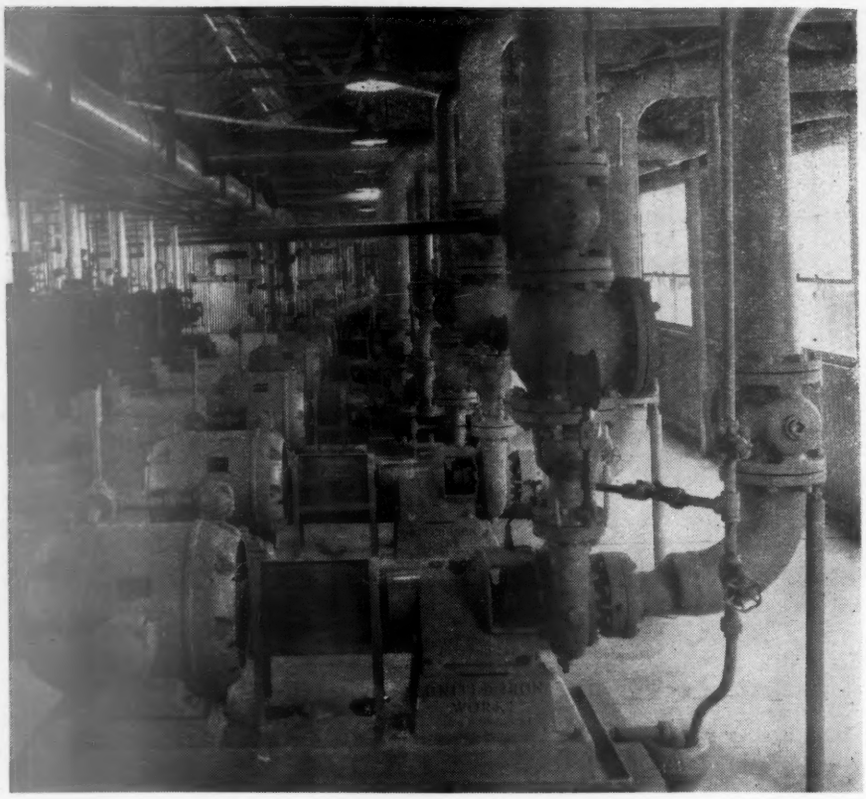

Pump arrangement in a gasoline plant pump house. Note the pleasing symmetrical equipment arrangement. Working space and convenience for operators are apparent.

tors and exchangers with the operating side of the towers. In a large plant this plan spreads the towers too far apart for operating convenience.

Room must always be left to the rear of the equipment row for maintenance and repair of exchanger and condenser bundles. A minimum requirement beyond the end of the exchanger head is room for a truck plus the length of the bundle.

There is some argument for condenser structures in gasoline plants. A refinery type arrangement with condensers on the upper level, accumulators in the middle and pumps underneath is sometimes used. Primary advantages of this arrangement are: (1) operating convenience due to grouping equipment, (2) downflow and free draining from condensers to accumulators, (3) short and convenient pump suction piping, (4) some centralization of control points, and (5) some saving of pipe.

Disadvantages are: (1) expense of supporting structure, (2) longer overhead lines from towers to condensers, (3) elevated condensers are more difficult to handle in maintenance, (4) operators must climb stairs to check control points, and (5) much more complicated piping layout which means added design and construction time.

The design, materials, and construction of this arrangement may total as much as 15 per cent higher cost than arrangement at ground level.

Space and construction cost can usually be saved by setting condensers and exchangers two high where possible. Piping and maintenance costs will be increased. The most economical and satisfactory overall arrangement is with all exchanger equipment at ground level. No structure. No stacking of units.

Instruments. The plant instrumentation must be considered in equipment location. The instruments and controls are operating equipment. They are the heart and nerves of a plant. To be of the most effective use they must be properly located.

Centrally placed controlboards containing a majority of the plant instruments are sometimes used. When the central board is used, it is usually housed in a controlroom as convenient as possible to the entire process area. Controlrooms do centralize instrumentation. The most critical instruments are grouped and can be checked rapidly without walking from point to point. The building is protection for the instruments and a haven for the operator in bad weather. In some climates, the controlhouse is a must. In milder climates it is an expensive luxury.

If a central board is used, the operator should be able to check every critical point in the process from the board. All recording instruments should be on the board. All pressures, temperatures, flow and levels important to plant operation should be board-mounted. There really is no point in centralizing a portion of the instruments. The operator still must tour the plant to get a true picture of operating conditions.

The central controlboard always requires longer instrument leads, more complicated instrument tubing supports and congested instrument piping. This is all in addition to the expense of the building itself.

When automatic instrumentation of gasoline plants first began no one thought of placing the instruments any place except adjacent to the equipment they served. There are still advantages to this plan. It is definitely more economical to install. When the instrument indicates an upset the operator is adjacent to the equipment and valves and can make immediate adjustment. Usually it is possible to see the locally mounted instrument from the equipment it is controlling. This is convenient at times when manual control is necessary. There are some applications where the local mounted instrument is required.

Some of the disadvantages are obvious. It is expensive to weatherproof individual instruments. The operator is inconvenienced when he must walk in and out and all around equipment to separated local instruments to check the operation of a unit. Changing charts on local instruments in the rain is really a problem. The plant will probably look very cluttered with all local instrumentation.

Again a compromise arrangement is probably the answer in the majority of plants. Locally grouped instrumentation has many of the advantages of both the local and centralized arrangements—and fewer disadvantages than either. The instruments for each group of operating equipment can be located together under a small instrument shelter convenient to the equipment served. The instrument leads are short. Instruments are close to control points and convenient for operation. The grouped instruments can be protected more economically. An inexpensive shed provides protection for the operator when changing charts or repairing instruments.

This arrangement does not provide the complete weather protection of a central controlhouse. It is more economical and more convenient for operation. In severe climates there is just no answer except the central controlhouse.

Storage Area Layout

The arrangement of equipment in the storage area may be less critical than any of the other areas. This is only because operation and maintenance time is less.

Naturally tanks containing the same products should be grouped. Piping is simplified. The uniform arrangement looks better. Tanks containing similar products generally should be adjacent. Again this simplifies piping—especially when the same pumps are used on two or more services.

Pressure storage tanks are normally elevated at least a few feet. This is required to provide pump head for light products. It is most economical to set these tanks on common pier supports. The tanks can be just far enough apart for maintenance. About 2 ft is minimum between horizontal tanks.

Vertical atmospheric storage should be spaced farther apart. Some safety regulations will require dikes around these tanks. Where they are required, the dike capacity will usually set the tank spacing. General good practice does not permit spacing tanks of this type closer than one tank diameter.

Primary considerations in location of storage equipment are provision for future expansion and economical piping.

Each bank of storage tanks should be so arranged that there is room on one end or the other for additional storage of the same class.

The most economical piping will usually result if we lay out the routing of the product pipe lanes from process area to loading. Then place the storage tanks on each side of the pipe lane. Loading pumps would then be located just to the side of this same pipe lane between storage and loading. At least one turn or some offset in the piping is desirable for flexibility.

If above ground suction lines are used from tank to pumps then lines should be as short as manifolding will permit. Otherwise vaporization on a hot summer day will cause trouble.

Utilities

Just a word about the utilities that make the process plant operable.

Many of the comments made about compressor plants apply to engine driven generator plants. The two are usually adjacent in plant layout.

Adequate room must be provided between units. Overhead trolley rails are required for the power cylinders of the drivers. Usually it is not economical to install permanent handling facilities for the generator rotor or heavy flywheels. Handling of these parts is infrequent and temporary rigging is not difficult.

The boiler plant for a gasoline plant is not different from any small steam power plant. Possibly convenience of operation should be stressed a little more than usual. The gasoline plant does not always have a separate operator for the boilers.

Water storage, water treating and fire system pumps normally will be located adjacent to the boiler area. Operation of all of these facilities is critical in times of emergency in the processing plant. Equipment should be situated for maximum convenience under normal conditions. It must also be so arranged as to be of maximum benefit in case of fire or explosion in the other areas.

Summary

The plant layout must be suited to the geography of the site, the average weather conditions, location of access roads, etc.

The equipment location within the layout must provide for economical construction, ease and safety of operation, pleasing plant appearance and economy in maintenance.

In order to accomplish these aims, the same considerations apply in each area of the plant.

Adequate space between equipment is an advantage in many ways. It gives room for construction, adds to safety of operation, keeps the plant from appearing congested, and saves on maintenance time many times over.

Symmetrical arrangement of equipment in the natural order of flow is important. It is an aid to the operator during the period of familiarization. It helps prevent mistakes in times of stress. It is usually the most economical arrangement for piping. It gives a better working plant.

If we add, then, a little humane consideration for the designers that must work out the piping, the men who build the plant, the operator who has to live with it, the executive who wants to be proud of it, and the company as a whole that own it, we have the required fundamentals for good gasoline plant equipment layout.* *

(Part 3 Will Be Published Soon)

New Projects Expected to End Sulfur Shortage

An all-out drive by free world nations to end the shortage of sulfur threatening the allied defense program was reported in Morgantown, West Virginia, by J. C. Carrington, assistant to the president of Freeport Sulphur Company, before the American Institute of Mining and Metallurgical Engineers.

He listed 46 projects, including 24 in the United States, to produce sulfur in different forms from various sources. These are expected to yield, on the basis of present estimates, approximately 3,000,000 long tons of the mineral by the end of 1953.

Government sources have placed the world shortage of sulfur at 1,000,000 tons annually.

Sulfur is important to the manufacture of critical items such as fertilizer, chemicals, rubber, steel, gasoline, paper, and explosives and therefore indispensable to defense production.

"It will be some time before the new sulfur projects can narrow the gap between supply and demand," Carrington told the fall meeting of the A.I.M.E.'s industrial minerals division at the University of West Virginia. "With defense production mounting, the sulfur shortage probably will get worse before it gets better. But large new additions to the supply are in prospect."

These he listed as:

(1) Twenty-four projects in the U. S. Four are new brimstone mines and one the expansion of an existing mine with a total anticipated new production of 1,200,000 long tons of sulfur. One of the new mines already is in operation. A second is scheduled to start production in the first half of 1952, another by the end of the same year, and the fourth, the newly discovered deposit at Garden Island Bay in Louisiana which Freeport will develop, by the end of 1953. Other projects are expected to add 350,000 tons of sulfur from natural gas, petroleum refinery gas, smelter gases, pyrites and low-grade surface deposits of sulfur.

(2) Seven projects in Canada and four in Mexico with an estimated new production of 500,000 tons of sulfur in all forms. A plant to mine sulfur by the Frasch (hot water) process will be built at a salt dome desposit on the Mexican Isthmus of Tehuantepec.

Expansion of pyrites production in Spain by increasing the annual rate of output at mines in Huelva Province by an amount estimated to be the equivalent of 400,000 long tons of sulfur. The Spanish mines have vast reserves, but production is now a little more than one-half the prewar output.

(4) Increases planned by Italy in the output of native sulfur amounting to about 250,000 tons yearly.

(5) Projects in Great Britain, Australia, Colombia, Japan, Norway, and Ecuador to obtain more sulfur in various forms from anhydrite refinery gases, pyrites, and native deposits.

Carrington said free world sulfur production from all sources this year probably will exceed 1950 output of 10,700,000 long tons of which about 6,000,000 tons were contributed by the U. S.

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Differential Head Meters Useful to the Petroleum Industry†

Some rate-of-flow meters suitable for fluids ranging from crude oils through the volatile refined gasolines to gases

HOWARD S. BEAN*

DIFFERENTIAL head meters for fluids are unique in that the metering elements, usually called the primary elements, are identical for both liquids and gases. Also, the secondary or recording elements may be the same, or nearly the same, except for possible differences in the scale range and details of connecting the primary and secondary elements. Finally, the factors (flow coefficients, etc.) to be used in computing the flow of either liquid or gas, may be obtained from the same set of curves or tables for most, but not all conditions that may be of interest in the petroleum industry.

Now all differential head meters are not equally suited for the different service conditions. Indeed, some meters have distinct advantages for some service conditions and others just as distinct advantages for other conditions. Therefore in this paper I shall try to point out, from the standpoint of the petroleum industry, some of these advantages and disadvantages, and to mention a few of the recent papers in which more detailed information may be found. Also, as the petroleum industry is concerned with gases as well as liquids, meters for both these fluid phases will be considered.

The types of differential-head meters which will be included in this discussion are the three well-known forms: The venturi tube, the flow nozzle, and the thin-plate square-edge orifice. Other types that will be mentioned are: The tapered tube and plug, the elbow, the Gentile flow tube and friction flow meters.

Venturi Tube

The conventional design of the venturi tube (Hershel type) is illustrated in Fig. 1. Various modifications of this design have been tried, and some of these modifications may have some advantages under some conditions. The curves for the discharge coefficients of venturi tubes given in the report of the ASME Fluid Meters Committee,[1] however, apply specifically to the Hershel design.

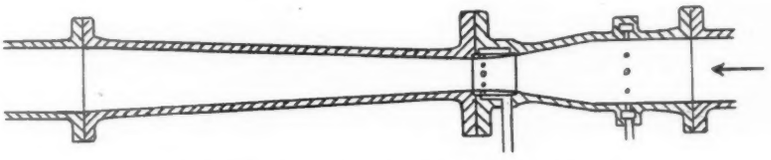

FIG. 1. Section of a Hershel type Venturi tube.

In use venturi tubes are relatively free from clogging due to sediment or other foreign material carried by the stream, and when used to meter stable fluids, especially liquids such as water, the indications are consistent and relatively accurate. In general these tubes are completely fabricated in a shop where appropriate attention can be given to the details of finishing. When installed as a unit, the possibility of defective finishing and assembly in the field is minimized. In addition the indications of these meters are possibly the least affected by installation conditions of the three leading types of differential head meters.[2]

On the other hand, the venturi tube, for a given pipe size, is by far the largest, heaviest, and most expensive of the primary elements discussed herein. It is difficult, if not impracticable, to alter the metering capacity of a tube by changing its throat size without changing the entire unit.

Flow Nozzles

The outlines and proportions of the curves, recommended by the ASME Research Committee on Fluid Meters, for defining the flow surfaces of flow nozzles are shown in Fig. 2. The research program on flow nozzles[3] conducted by that Committee, showed, however, that the proportions of the curve generating the flow surface are less important than the quality of the surface finish.

Although a flow nozzle itself will occupy a little less than 2 pipe diameters, the length of straight pipe required for its proper installation and operation will be at least 6 pipe diameters on the inlet side and 2 on the outlet, and greater lengths are desirable. Thus the overall space required for a flow nozzle will be nearly the same as for a venturi tube.

An advantage of the flow nozzle (over the venturi) is that a flow nozzle may be changed so as to provide a different flow capacity for a given head. To be sure this requires that one of the adjacent sections of pipe, preferably the inlet section, be removable. On the other hand there is a tendency for any dirt in the fluid stream to collect against the inlet face of a nozzle, especially when the nozzle throat diameter is small compared to the pipe diameter.

An important characteristic of the flow nozzle if used to meter gases obtains when the outlet pressure is equal to or lower than about 55 per cent of the inlet pressure. The jet velocity is then unaffected by further reductions in the outlet pressure. This means that the volume rate of flow at the inlet conditions is constant and independent of changes in the outlet conditions so long as the outlet pressure remains below the critical ratio. Because of this characteristic the smaller sizes of flow nozzles are often used for the dual purpose of flow regulation and flow measurement.

Orifice Meter

The concentric thin-plate, square-edged orifice is not only the simplest but by far the most widely used of all the primary elements for rate-of-flow meters. The orifice plate is relatively easy to reproduce; the most important requirement in finishing an orifice plate is that the inlet edge of the orifice shall

†Presented at the Petroleum Mechanical Engineering Conference, Tulsa, Oklahoma, September 24-26, 1951, of The American Society of Mechanical Engineers.

*Chief, capacity, density, and fluid meters section, Mechanics Division, National Bureau of Standards, U. S. Department of Commerce.

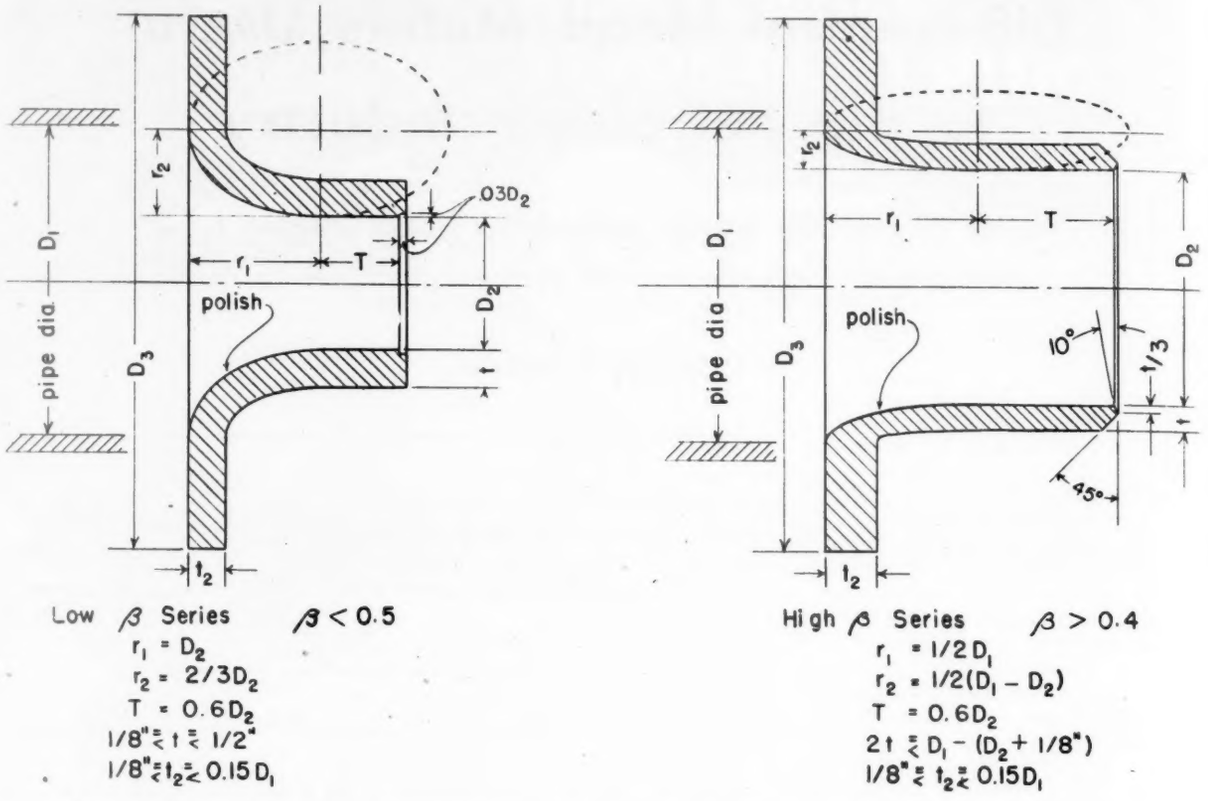

FIG. 2. Dimensional relations of ASME long-radius flow nozzles.

The recess and the double bevel are suggested methods of preventing damage to the nozzle outlet. Other means of protecting the nozzle outlet may be used. When a nozzle is to be installed between pipe flanges the diameter of the nozzle flange, D_3, should be proportioned to fit within the bolts with at least 1/16 in. clearance. Other methods of mounting a nozzle may be used.

be absolutely square and free from any rounding or wire edge. Failure to produce and maintain a square edge will result in unreliable measurement. The most familiar method of installing an orifice plate is to clamp it between a pair of flanges, either ordinary pipe flanges or flanges especially made for the purpose as shown in Fig. 3. In such a mounting, changing a plate to meet changes in the metering load requires only a slight spreading of the flanges. In recent years special fittings for holding orifice plates have come into common use which makes changing orifice plates even easier.

Dirt and other foreign material carried by the fluid are apt to collect against the inlet face of an orifice plate and this may affect the accuracy of the measurement.

Two special forms of the orifice are the eccentric and the segmental orifices. With these two forms the center of dam is placed in line with the pressure taps. The principal advantage of these forms, over the concentric orifice is that for a given (large) area ratio a larger pressure difference is obtained. A secondary advantage may be that if the fluid stream is dirty the opening may be so oriented as to minimize the accumulation of dirt on the plate.

Installation

The installation requirements to insure good metering conditions for head meters have been and still are the subject of study both in this country and abroad. For the primary elements so far discussed the requirements will be much the same, and a safe guide to follow is Report No. 2 of the (Natural) Gas Measurement Committee of the American Gas Association. To be sure, the recommendations in that report are very conservative, that is the lengths of meter runs prescribed are longer than may be altogether necessary in many cases.

For that matter, one or two papers that have appeared since the above report was prepared have indicated that shorter meter runs may be used in some cases without loss of accuracy.[4,5]

It is appropriate to mention here the research program on the construction and installation requirements for orifice meters, which a Joint Committee of the AGA and the ASME has been carrying on for the past three years. This program is directed towards providing information on the following items:

1. What distance should be provided between a plug valve and the orifice plate?
2. What distance should be provided between a globe valve or expansion bend, or both in series, and the orifice plate?

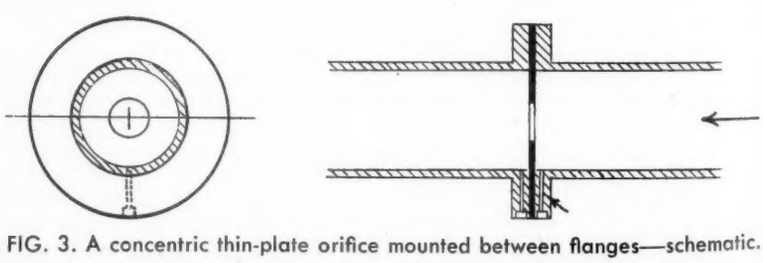

FIG. 3. A concentric thin-plate orifice mounted between flanges—schematic.

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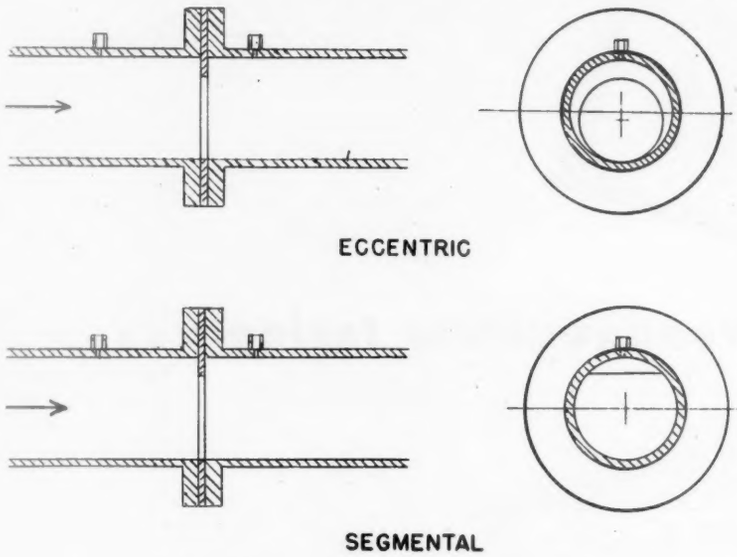


FIG. 4. Eccentric and segmental orifices.

3. Will either a plug valve or globe valve in the riser to a meter run have the same effect as in the meter run?
4. Will the required lengths of straight pipe be proportional to the pipe size?
5. Can the flange type of orifice plate mounting be replaced by an orifice meter fitting without affecting the accuracy of measurement?
6. What limitations and tolerances should be applied to the size and locations of pressure holes?
7. To what extent may the quality of the inside pipe surface affect the indications of orifice meters?

A full account of these tests with the results and conclusions to be derived therefrom will be made by the committee as soon as possible after the field work is completed. Up to the time of writing this test work and computations on only item 5 have been carried far enough to justify any statement. In the use of orifices meter fittings, if the fitting is carefully aligned with the inlet section of pipe, there was no appreciable difference between the indications with the fittings and with the regular flange mounting. Also the coefficients obtained with water, for the same orifice plates, were the same with fittings and flanges. Finally, with gas, no leakage was detected around a plate (but within the fitting) where a rubber seal ring is used in connection with the mounting of the orifice plate in the fittings.

Range of Flow Rates

For a given primary element setting in any of the several forms of head meters discussed above, the minimum to the maximum rate of flow that may be metered may be extended almost without limit, theoretically. Practically, it is seldom desirable or advisable for the ratio of the maximum to minimum rate to exceed about 1 to 5, and 1 to 3.3 would be a more conservative value. To illustrate one of the reasons: Assume that for a given meter the differential pressure is measured with a U-type water manometer having 100-in. scale. If we take 1/20 in. as the average uncertainty in reading such a gage, this represents 1 part in 2000 at the full scale. At 4 in. of 1/25 of the full scale, corresponding to 1/5 of the full scale flow rate, the 1/20 in. represents 1 part in 80. If the rate were decreased further the relative uncertainty will increase very rapidly. If the differential pressure were measured with a recording chart gage the increase in the relative uncertainty would be even greater because the scale on such a chart is compressed.

On the other hand, assume that 4 in. of water represents the differential pressure for the designed minimum rate of flow. If the rate were increased six-fold, the differential would be increased 36-fold. Although it might be possible to use a differential gage having a range adequate for such pressure, the overall pressure loss might be prohibitive.

For both Venturi tubes and flow nozzles the discharge coefficient decreases as the flow rate decreases. If we take a differential pressure of somewhere between 10 in. and 4 in., as representing a low rate of flow, the uncertainty in selecting an appropriate discharge coefficient value, from curves or tables, will increase progressively as the rate of flow decreases. For square-edged orifices the discharge coefficient increases as the rate of flow decreases, so that here also it becomes a problem of reading from the steep part of a curve with a corresponding increase in uncertainty of selecting the appropriate coefficient.[6]

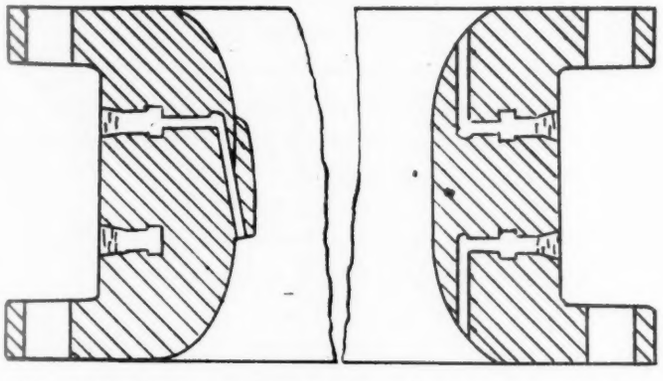


FIG. 5. Half sections of gentile tubes showing two methods of making the pressure openings.

Tapered Tube and Plug

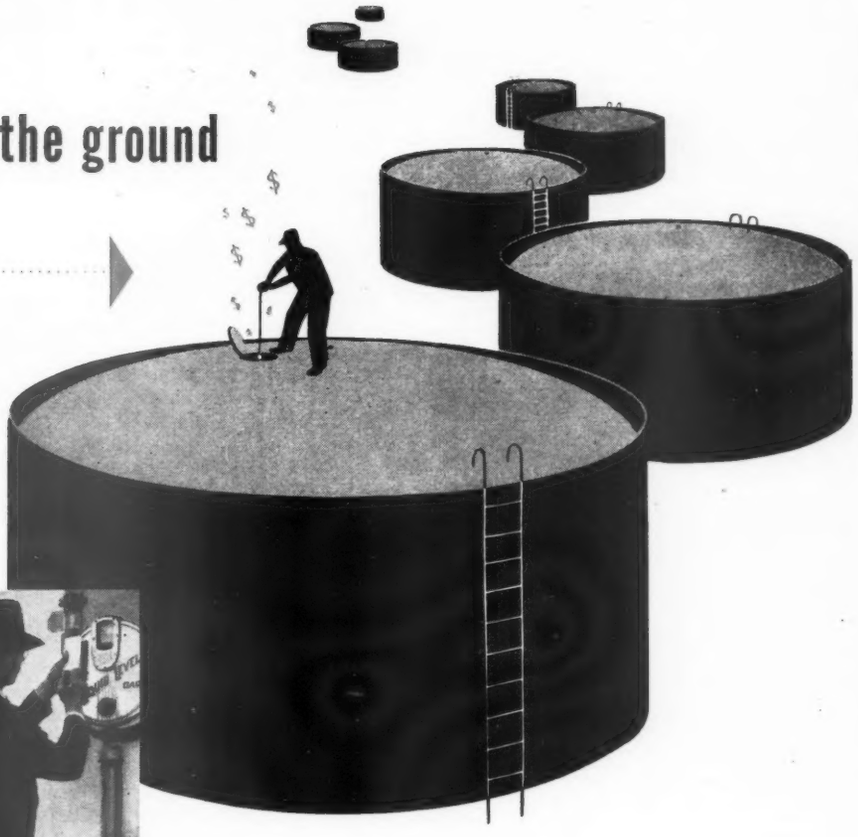
These meters, in contrast to those discussed above, have a constant head with a variable area. The differential pressure is equivalent to the force required to maintain the float at any position in the tube.

Meters of this type are made for use with both gases and liquids, and for a wide ranges of rates of flow. The range of rates that any one instrument will handle, however, will depend upon the angle of taper and length of the tube. Ordinarily these meters are used to indicate only the rate of flow, and the fact that the position of the float indicates the rate of flow at the instant of observation, is an outstanding advantage. It is possible to equip this type meter with an integrating attachment.

No general data are at hand to indicate how closely ostensibly similar tapered tube and plug meters will agree. Therefore it is suggested that a meter of this type be calibrated if the service requires a known degree of accuracy.

These meters are used extensively in

keep his feet on the ground



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laboratories, testing departments, control plants, and other similar places where close observation and regulation of rate-of-flow is desired. It is possible, however, to obtain such a meter for almost any common pipe size and kind of fluid.

Elbow Meter

Almost any elbow, in the pipe line through which the fluid to be metered is flowing, might be used as a rate-of-flow meter by measuring the difference in pressure between the inner and outer circumferences. The pressure holes used for this measurement should be located in the mid-plane of the elbow, and at an angular displacement from the inlet of the elbow curve of between 45 and 55 F.

Although an elbow may be used for metering either a gas or a liquid, the differential pressure when metering a gas probably will be rather low for accurate measurement. Before an elbow is used as a meter, it is necessary to calibrate it. Such a calibration should be made with the same kind of fluid and over the range of rates of flow to be encountered in use.

There have been one or two attempts to make special elbows to be used as meters, which have met with very little acceptance. The elbow is mentioned here only as a suggestion for those cases where only an approximate measurement is required.

Gentile Flow Tube

This is a proprietary design in which an effort is made to combine some of the features of the venturi tube and the impact tube. The main body is a short nipple-like section about 2 pipe diameters along with a constricted central section. The curving contour of the inner surface is symmetric about the midsection so that the tube may be mounted in either direction. In some models the inlet and the outlet pressure holes are situated in the curved inlet and outlet surfaces close to the point of junction with the pipe, and with the centerlines of the holes parallel to the axis of the tube. In other models the pressure holes are located in 6 small bosses protruding into the tube near the midsection, the holes in 3 bosses facing in one direction, those in the other bosses facing the opposite direction. Thus, with both types of pressure holes the differential pressure that is measured is due in part to the change in velocity, as with a venturi tube, and in part to a positive and negative impact pressure. A true "static" pressure measurement, however, cannot be obtained from either type of pressure hole. Hence if a gaseous fluid were being metered and the true static pressure were desired in order to determine the gas density, a sidewall pressure hole would be required, located in the pipe preceding the flow tube.

An account of calibration tests on a number of these tubes was presented before an ASME meeting in December 1949 by Professor L. J. Hooper[7] and supplemented with additional data by Professor W. S. Pardoe. All of the tests reported in that paper were made with water. Although other fluids such as oils and gases could be metered with these flow tubes, no reports of such use have been noticed.

Friction Flow Meters

This name is applied to that group of head meters in which the rate-of-flow is proportional or nearly proportional to the first power of the differential pressure. They are not suited to large quantity measurements, and are mentioned here only because there may be instances in some petroleum pilot plant or laboratory where it will be required to regulate or meter a very small flow.

The most common forms of these meters are the porous plug and the capillary tube. The porous plug form may be made by securing a plug of porous material within a suitable tube. Pressure connections are made to the tube on either side of the plug so that the pressure drop across the plug may be measured. Cotton, steel wool, and glass wool have been used as plug material. It has been suggested that a plug of sintered material could be used at elevated temperatures. So far the porous plug type has been used almost exclusively with gases and for such use some general criteria[8, 9] have been developed which will be useful both as design guides, and for flow computation factors if one does not wish to calibrate his meter.

The capillary tube form, as its name implies, uses a tube of small bore as the pressure-drop producing element. To obtain a pressure-drop sufficient for satisfactory measurement, a relatively long tube may be needed. This will place the pressure connection, which must be made beyond the ends of the tube, rather far apart. The entrance and exit ends of the tube should be well flared and smooth so as to reduce turbulence. Clean liquids as well as gases may be measured with these flowmeters. A short but fairly complete paper on capillary tube meters was written several years ago by A. F. Benton.[10]

Secondary Elements

So far in this paper only the primary elements of rate-of-flow meters, have been discussed, that is, the part of a complete meter unit through which the fluid passes. To have a complete meter requires a secondary element by which the differential pressure, produced by the primary element, is measured. If the fluid being metered is a gas, it will be necessary that the secondary element include a pressure gage by which the static pressure may be measured. The instruments forming the secondary element may be simple manometers, indicating pressure gages or recording pressure gages. There may be also an integrating element that will compute from the pressure measurements, the fluid quantity in units of volume or weight, and tally these units. Lastly there may be a temperature element by which the temperature of the fluid will be indicated, recorded, or made to modify the tally of the integrator.

The particular design of secondary element used at any given place will depend in part upon the fluid being metered, the operating conditions, and the purpose and importance of the measurement. In the metering of natural fuel gas the most common type of secondary element is a recording static-differential gage unit. Records of the stream temperature and specific gravity, if desired, are most often obtained with separate instruments. For the metering of water and steam, as in power plants, the secondary element usually includes an integrator in addition to making records of pressures and temperatures. In the metering of oils and especially the refined products, an integrating type of secondary element would be applicable.

No over-all statement can be made of the accuracy obtainable with rate-of-flow meters. There are a number of cases on record in which orifices meters in parallel and series combinations have agreed within a small fraction of one per cent over extended periods. There have been reported also cases of similar agreement being attained in comparison with other types of measurement. However, it cannot be claimed nor expected that a high degree of accuracy or precision will be attained with all rate-of-flow meter installations. As with all types of meters, if consistent and satisfactory measurements are to be had, not only must the initial installation be properly made, but persistant attention must be given to see that the metering equipment is maintained in proper condition.

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* * *

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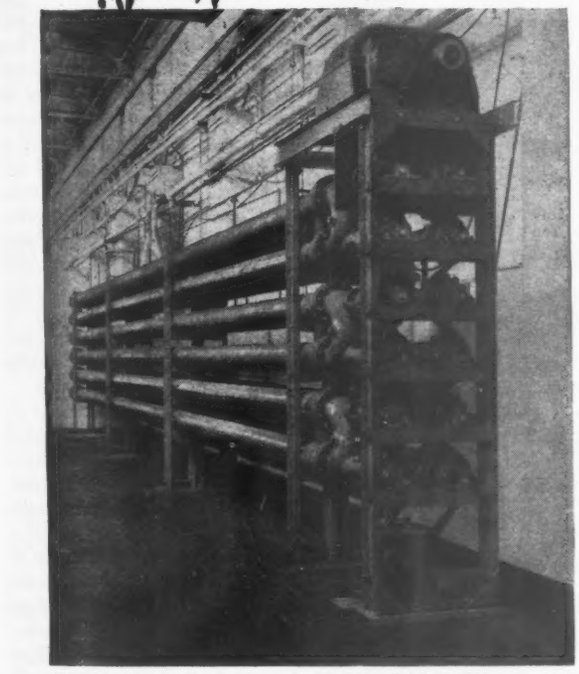

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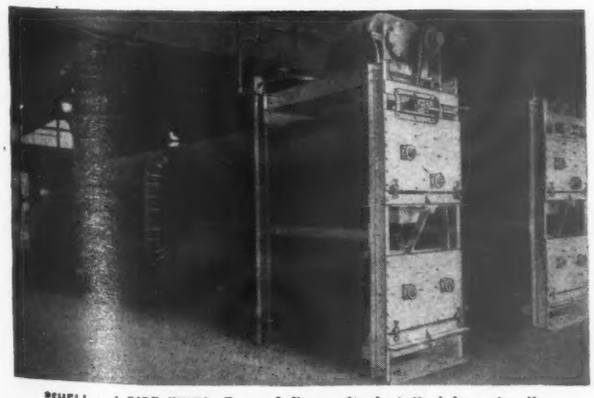

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Two columns in foreground are the rerun still and the butane splitter in Sunray's Snyder plant; in background, are the depropanizer and butanizer columns.

Snyder Gasoline Plant Fed by 850 Wells

High pressure gas used as 'prime mover'; air-cooling reduces water requirements

ARCH L. FOSTER*

THE multiplicity of wells indulged in in oil fields of an earlier day with its attendant wastefulness, excessive per-barrel costs and loss of gas, oil, and productive underground pressures has given way to proper and scientific well spacing, repressuring, conservation of gas, and gas pressure. These modern practices are nowhere displayed to greater advantage than in the "collaborative" natural gasoline plant operated by Sunray Oil Corporation in the Kelly-Snyder area of Scurry County, Texas, and the 846 wells which that plant serves. This plant and its gas-gathering system have some unique, though not necessarily all new, methods in the design and operation of the system that make it an interesting unit from the viewpoint of the plant designers, operators, and technologists in the natural gas-gasoline field.

Originally designed for handling 50,000,000 cu ft of raw gas per day, early work indicated that greater capacity was necessary to service the field output properly. So the capacity was boosted by methods explained later in this article. The average recoverable liquid hydrocarbon content of this gas in mid-1951 was about 6.5 gal per 1000 cu ft; this concentration is expected to be about 8 gal per 1000 cu ft when the full gas stream is "lined out". The entire system is actually in two parts, the gas-separating and gathering system, and the liquids recovery plant proper. For convenience, mainly, the recovery plant will be discussed first.

Equipment and Design of Plant

The essential equipment of the plant does not differ essentially from that of any well-designed natural gasoline plant of today. Its main units include seven Cooper-Bessemer ten-cylinder, 3-stage compressors of, originally, 1100 hp rating. When the design capacity was increased these compressors were supercharged to enable them to operate at 1350 hp to handle the additional 20,000,000 cu ft of gas. The compressor cylinders are arranged with two cylinders on the low stage, one on the intermediate stage, and two on the high stage. A Fluor pulsation-dampener system is installed in the compressor assembly in which each cylinder is treated separately and because of which smaller pipe sizes may be used satisfactorily.

Fractionation equipment includes the deethanizer-absorber, a column 125 ft in height by 8 ft diameter, with heads 1.6 in. thick, and containing 50 trays, divided evenly between the absorption section and the deethanizing section. Also a butane splitter column is installed, 150 ft high by 7 ft diameter, and fitted with 65 trays. A depropanizer and a debutanizer complete the main system for separation of products, all equipped with reboilers and other necessary auxiliaries.

A "solid" Perco unit is provided for treating the stabilized natural gasoline to remove mercaptans. A caustic washing assembly is employed to wash the propane fraction in two stages. This washed stream is dehydrated by a solid dryer unit equipped with a regenerative system, and then stored for market. Another important unit is the amine plant in which two reagents purify the gas. Monoethanolamine removes carbon dioxide from the stripped gas, which CO_2 ranges up to about 1.4 volume per cent of the gas stream, along with 1-3 grains of H_2S per 100 cu ft. Diethylene glycol is employed to reduce corrosion and eliminate foaming propensities.

All plant water makeup is lime-treat-

*Editor, Refining and Gas Processing.

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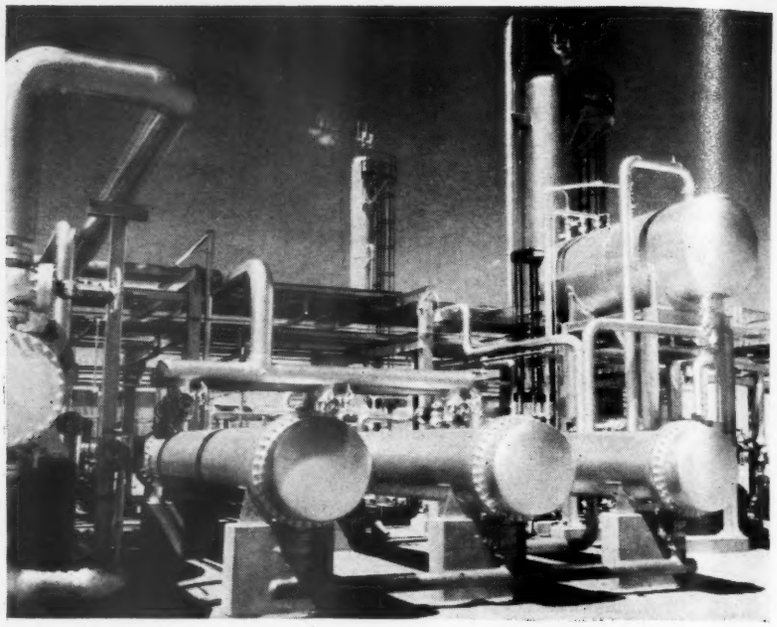
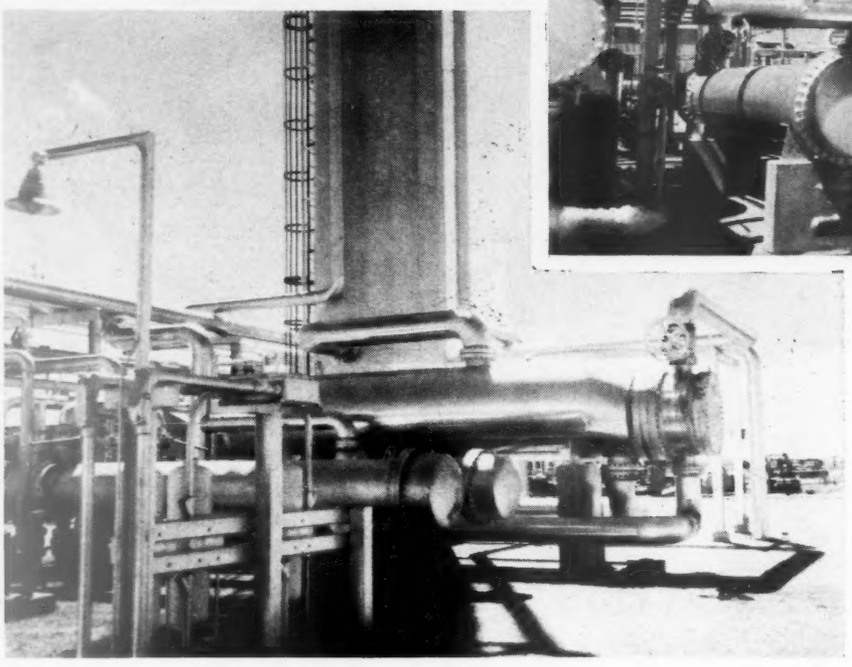
Overhead condensers for the butane splitter column.



Lean oil cooler-exchangers in front, with the absorber-reboiler in back, near the base of the absorber.



ed, followed by sulfuric acid addition on its way to the cooling tower. In addition, boiler makeup water is treated in a sodium zeolite unit, and finally addition of phosphate and of sulfite solutions, the latter a reducing agent, makes the water satisfactory for steam-making.

Water in the dry West Texas country is always a problem, so this plant is equipped with two air-cooling units, Fluor-GR Fin-Fan assemblies in one of which two streams, one the reflux for the still, the other the condenser for the debutanizer overhead, are included in the same unit.

An integral hot-oil heating system is employed to do most of the heating, reboiling, and stripping in the plant. This heating "circuit" is connected with the lean-oil system, and is used to heat the rich oil and the various reboilers and other heating units except as noted below. This system uses one direct-fired heater, and one main object was to reduce the plant's steam requirements and thus the rate of water makeup.

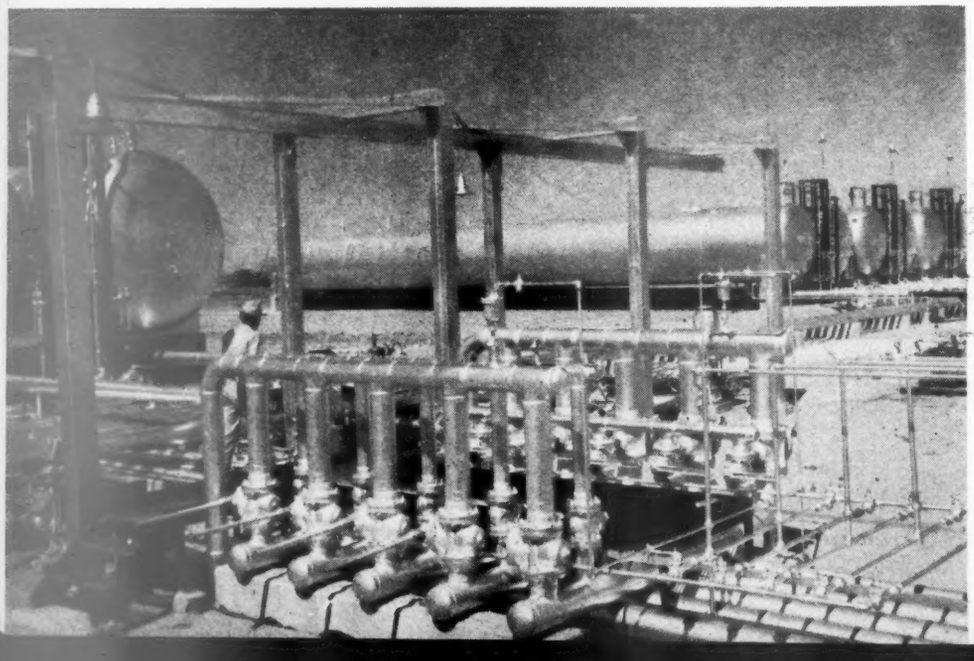
Plant steam needs are met by two package-type boilers that will each produce the more than 16,000 lb of steam per hour needed by the plant. The regeneration system for the propane dehydrator is steam heated. The amine solution in the CO_2–H_2S removal unit is also regenerated by steam heating. Steam is employed in the still as a stripping agent to remove the last traces of light material from the oil. A considerable portion of the power used in the plant is obtained from exhaust steam at elevated pressures, such as 125 psig, and from the high pressure gas, since all residue gas is taken off at 500 psig from the absorber. Required electric power is supplied by three gas-engine-driven generators of 500 Kw each, with a fourth unit as standby.

Various alloys are used in different parts of the plant. Tubes in the reboiler of the amine treater are of Croloy 5. Most of the remainder of the tubes in the gas coolers of the plant are of Admiralty metal; product coolers use Admiralty. The final condenser for the still is equipped with inhibited Admiralty. Other tubes are steel, in the main.

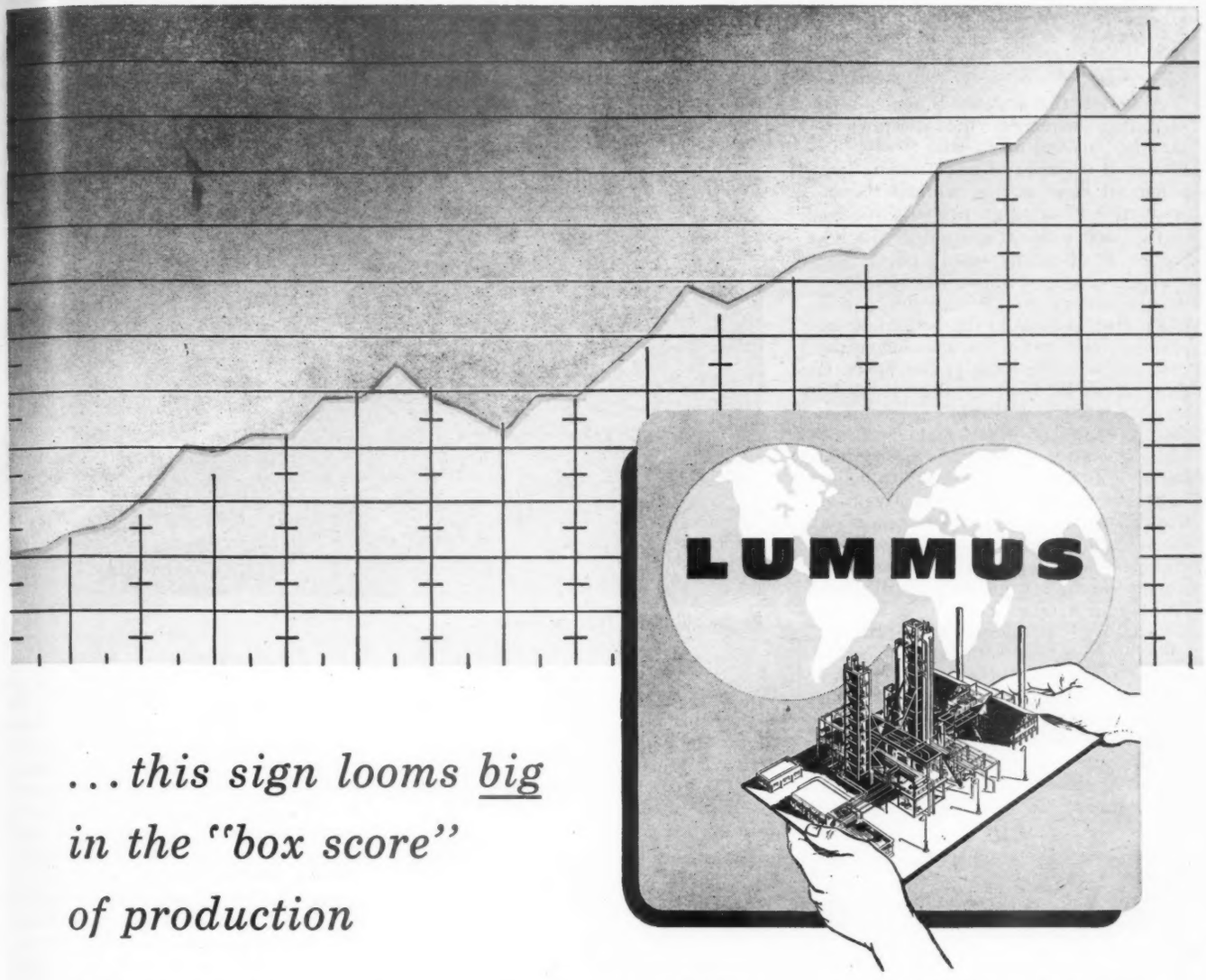
No special pumps are used; all pumps have 11-15 chrome steel shafts.

Plant Operation

Two streams of rich gas are brought into the plant. The low pressure gas is brought in at 0 to 10 lb pressure, the field separators on this low pressure system operating at 15 psig. Drip gasoline from this rich gas is brought in by a system to be briefly discussed later. This stream amounts to 37,000,000 cu ft per day and passes through the huge scrubber and to the first two stages of the compressors. Exhaust from the second stage, at about 170 psig is mixed



Gasoline header in storage area.



. . . this sign looms big in the "box score" of production

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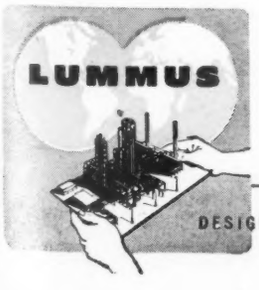
Isn't this a reassuring record for you to tie to? It strongly suggests that you think of Lummus first in your plans for petroleum refinery or chemical plant expansion.



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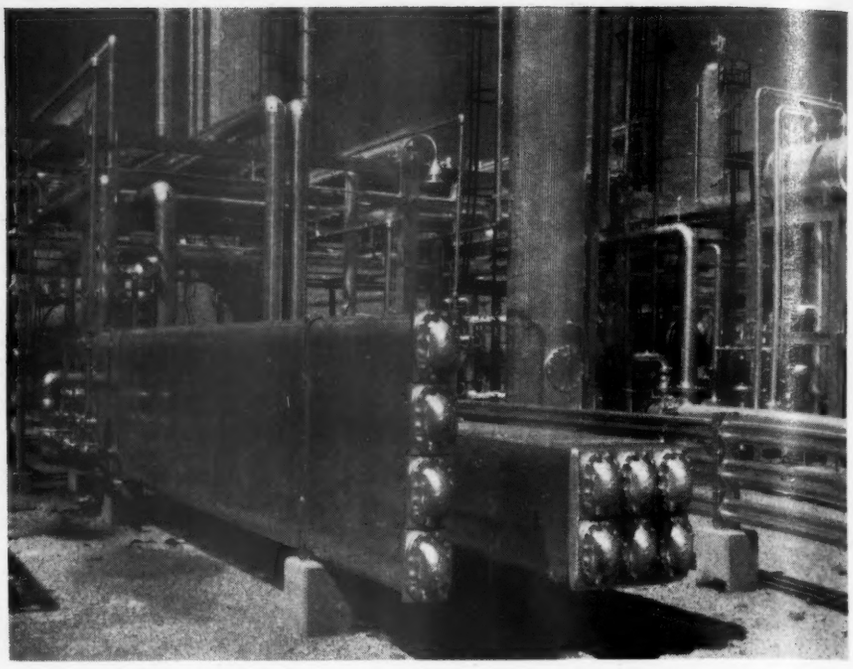
with 22,000,000 cu ft per day of high pressure gas at the same pressure, and the entire charge is brought up to 500 psig.

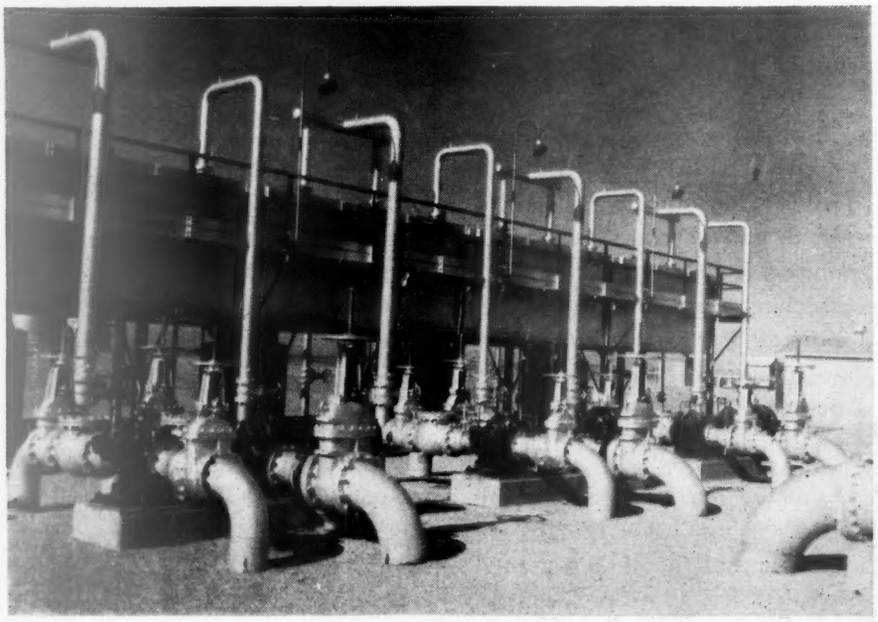
Although this routine is the normal operating sequence, the compressors may be "hooked up" to handle 40,000,000 cu ft or more of low pressure gas, using all three stages, without the introduction of the high pressure stream.

This 500 psig stream enters the absorber at about its middle-point. The absorption oil, of about 190 molecular weight, enters at the top and passes downward and out at the bottom of the reboiler. The reason for introducing the raw gas at the middle of the tower is that the lower half of the tower, 25 trays, is used as a deethanizer column, into which no raw gas is taken. At the tower's operating pressure this system has proved feasible. The kettle reboiler is heated by the circulating stream of hot oil, driving off the last traces of ethane and sending the deethanized rich oil, carrying 70 per cent of the total propane in the raw gas, to the still, after flashing in a tank at 135 psig to take off the load of lighter hydrocarbons, which pass in turn to the still. The still is also actually built in two "sections", the upper part being the fractionation section. Into the lower section the partially denuded absorption oil, after passing through exchangers, is flashed. As ethane has been removed, it is found practicable to condense all the overhead vapors from the still at a pressure no higher than 100 psig. The rich oil enters at 400 F onto the feed tray, is stripped with steam in the reboiler with a bottoms drawoff temperature on the lean oil of 357 F.

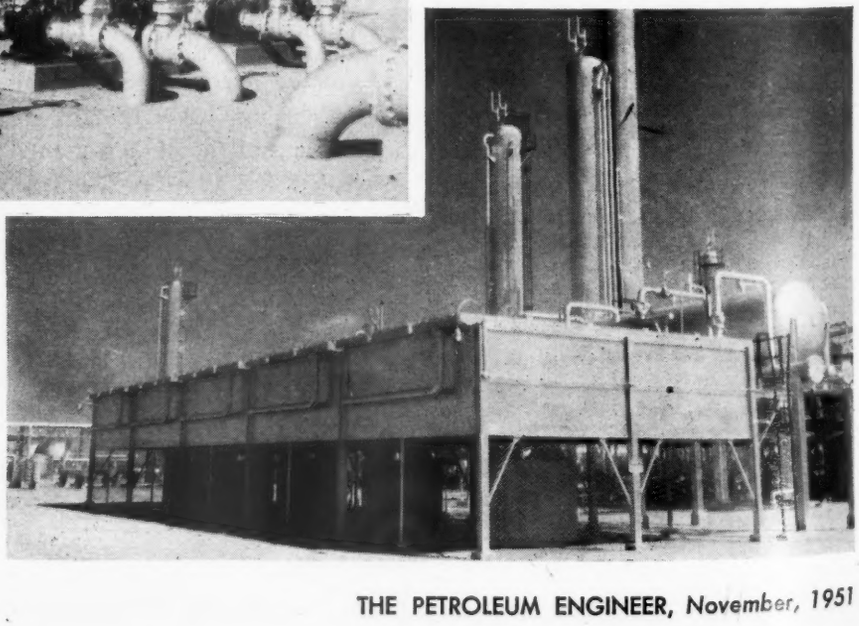


Rerun still G-Fin feed preheaters.

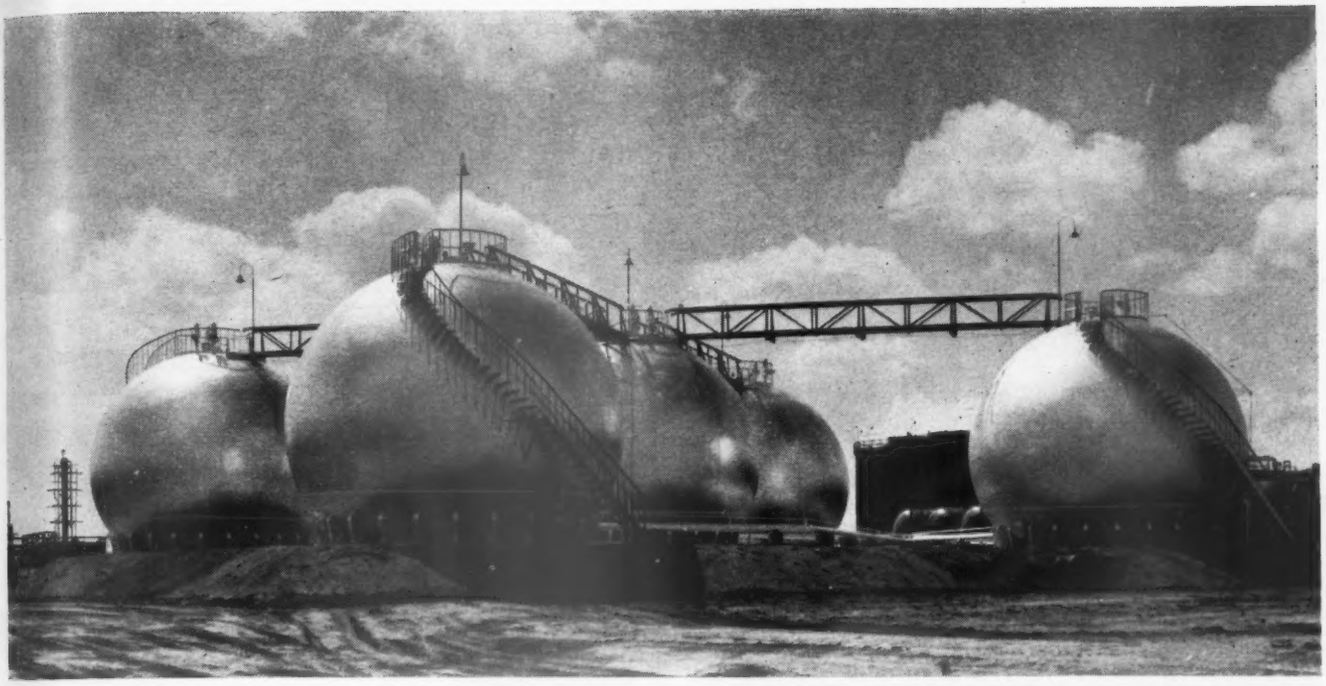
Overhead vapors from this still, the combined streams as mentioned above are condensed and sent to the depropanizer tower, from overhead of which a carefully controlled distillation-range propane (LPG) fraction is taken, condensed, washed in two stages with caustic solution, and stored for sale. Depropanizer bottoms are "split" in the debutanizer, which may do one of several operations. Usually the overhead from this tower is mixed normal and iso-butanes, while the gasoline is debutanized, of a low vapor pressure. If and when wanted, the conditions are held so that only part of the butanes are taken overhead, while an amount of butane is left in the bottoms to make a gasoline of any desired vapor pressure, such as 26 lb. In the event that appreciable quantities of butane are left in the gasoline bottoms, most or all of this normal butane, being the less volatile, while the



Battery of Air-Fin type coolers with product handling pumps in front.



Left to right: Three units of the debutanizer condenser; two units for still overhead condenser, of the Air-Fin type.

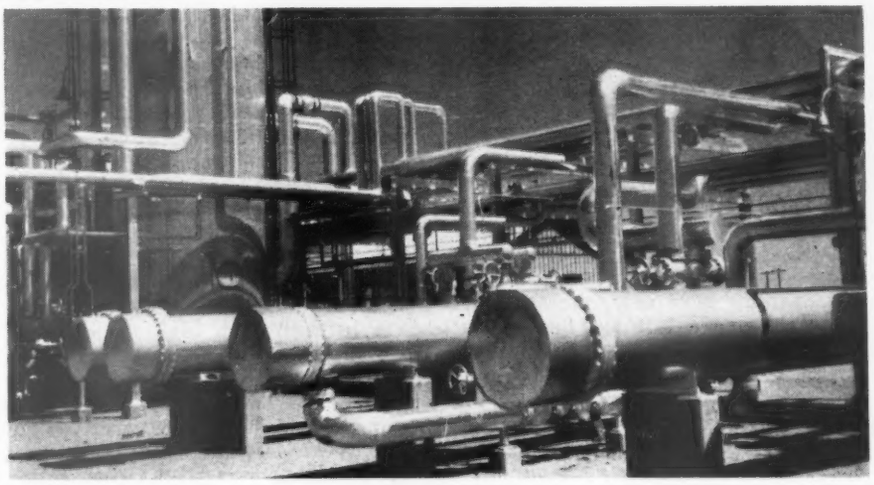


Interconnected battery of five 3000-bbl Hortonspheroids for light products.

overhead vapors will be correspondingly richer in isobutane.

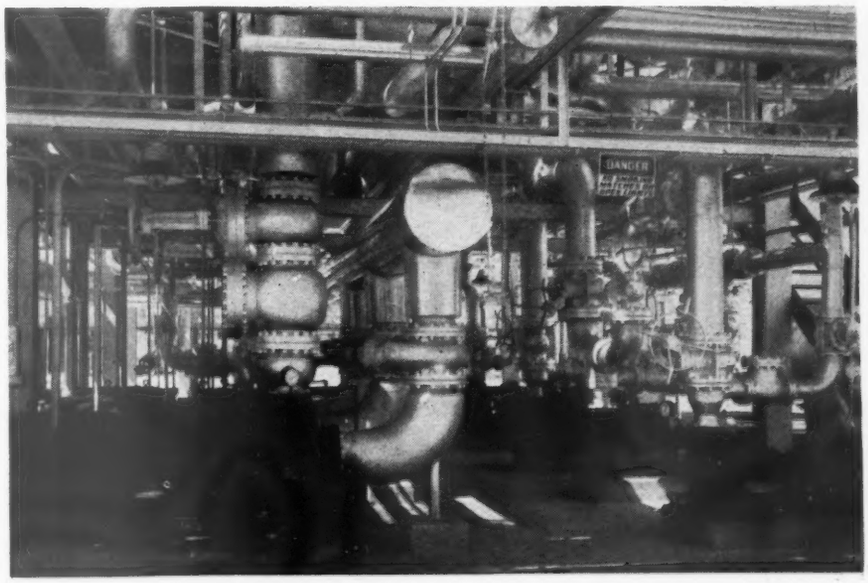
Part or all of the debutanizer overhead vapors go to the "butane splitter" column, which takes isobutane overhead at 95 per cent purity, with normal butane off the bottom; this stream is stored without treatment, and may be disposed of as such or blended with any other light stream, such as the portion of the debutanizer overhead that for any reason may not be sent to the butane splitter. An interesting item in connection with the operation of the fractionation system is that one set of Fin-Fan sections or cells are so connected that in each cell one part is used to condense reflux for the still and the other part is condenser unit for the debutanizer, which arrangement makes it necessary to employ higher operating pressures and, therefore, a heavier debutanizer column than are used customarily in conventionally designed units.

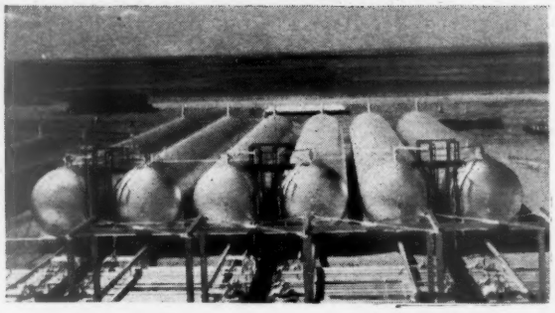
These operations under gas charge as supplied by the field under conditions obtaining in the recent past yield products totalling from 400,000 to 458,000 gal per day. As of one four weeks period of operations the average daily yield of recovered liquid hydrocarbons was 402,000 gal per day. This included 112,200 gal of pentanes and heavier (natural gasoline, debutanized), 95,000 gal of normal butane, 26,800 gal of isobutane, or 28.2 per cent of the normal butane yield, and 168,000 gal of specification propane. As mentioned, this propane represents approximately 70 per cent natural gasoline is stored in five interconnected Hortonspheres, as shown in the accompanying photograph. Other products are stored in the "bullet" tanks shown in the photographs.



Left to right: Two still overhead final condensers, rich oil preheater, and rich oil-lean oil exchangers.

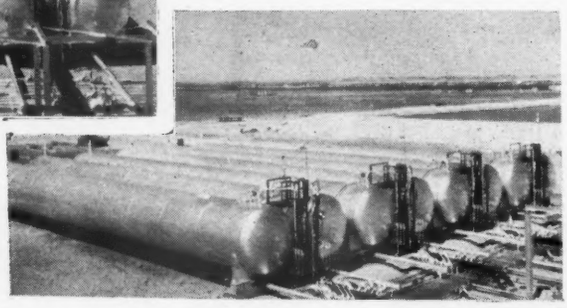
At left of this battery are lean oil pumps, with reflux pumps, right, and fractionator feed pumps in rear.



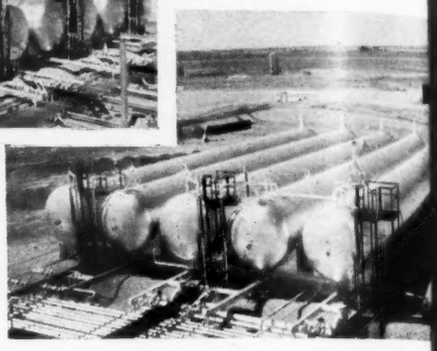


Butane storage tanks.

Propane tanks.



Light slops and storage battery.



Gas Gathering System

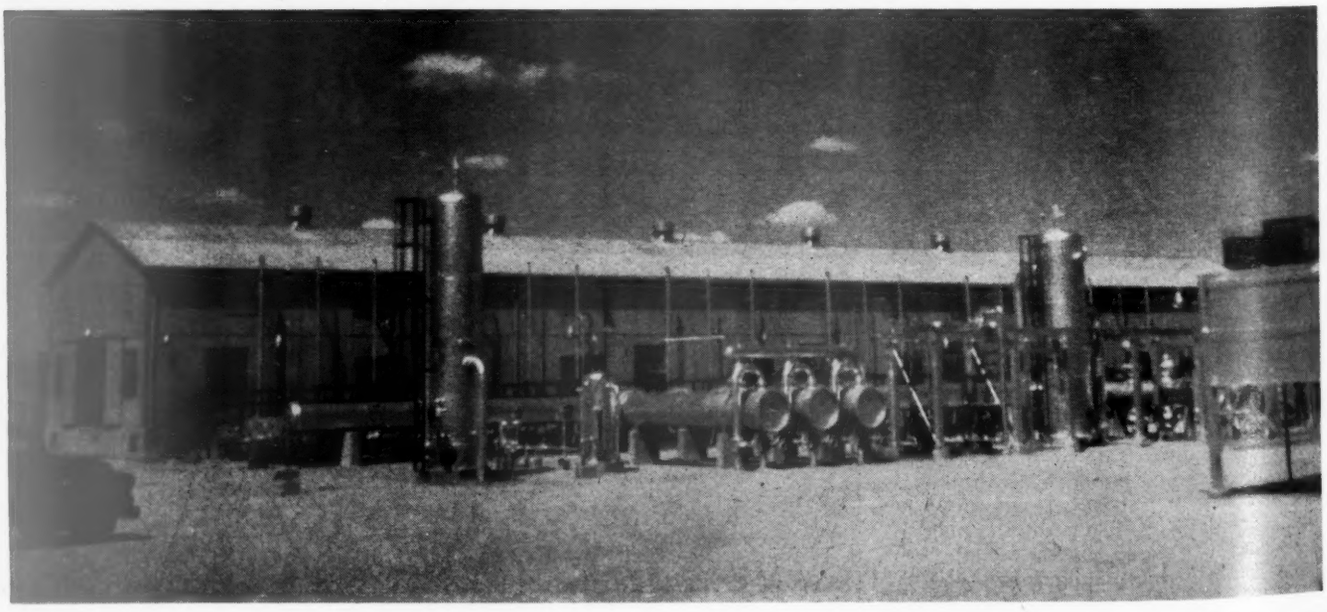
Some interesting operations are included in the field system for gathering the gas from the 850 wells served. The two systems, low and high-pressure, include some 90 miles of 2-in. to 8-in. high-pressure lines, which bring raw gas direct from the high-pressure lease separators to the plant, to enter the third compression stage as outlined earlier in this article. This system requires more than 160 meters to record the amounts of gas obtained from the various leases of the 30 companies and 60 individual producers in the field.

Low-pressure gas is collected in 140 miles of line, using 4-in. pipe on the individual leases and the combined stream coming into the plant scrubber through a 30-in. line. Because of the extraordinary richness of this low-pressure gas a unique system for handling drip gasoline (condensate) has been installed and operates admirably, the operators say. At low points in the line special pressure drums or "blow cases" are installed in concrete boxes or "cellars", and connected to the low point of the accompanying low pressure line. Liquid condensate flows into these drums; alongside the low pressure lines are laid the high pressure lines. An offtake line from the high pressure system inlets gas to the drip drum and forces the liquid through a special small line to the top of the next hill or ground elevation, where it reenters the low-pressure gas line and flows down to the next low point, where the process is repeated until the liquid enters the plant system. This arrangement eliminates a third gathering line alongside the two employed, and thus reduced the amount of steel required by many tons.

As the high pressure gas is taken direct from 200 psig operating separators, and the potential problem of paraffin wax separation looms large, the necessity for installing interstage heaters between each high stage and its corresponding low stage separator was agreed upon. By installing these heaters paraffin deposition was prevented or minimized in the oil lines carrying crude and in which gas pressure is being reduced. The low-stage separators operate at 15 psig, and because of the heaters the amount of gas yielded from this stage is equal to that obtained from conventional low-pressure separators at elevated levels but operated without heaters at atmospheric pressure. The operators state also that this interstage heating, two-stage separation system "smoothes out" the gasoline content of the gas produced, and prevents seasonal fluctuations in the gasoline content, delivering gas of essentially uniform gasoline and LPG content to the plant throughout the year.

Stripped gas from the plant is relayed to and sold to two gas companies, Lone Star Gas Company and El Paso Natural Gas Company. * * *

The compressor building in the background, with the high pressure scrubber, left, and the third-stage scrubber, right, and three third-stage gas cooler exchangers in center forergound.



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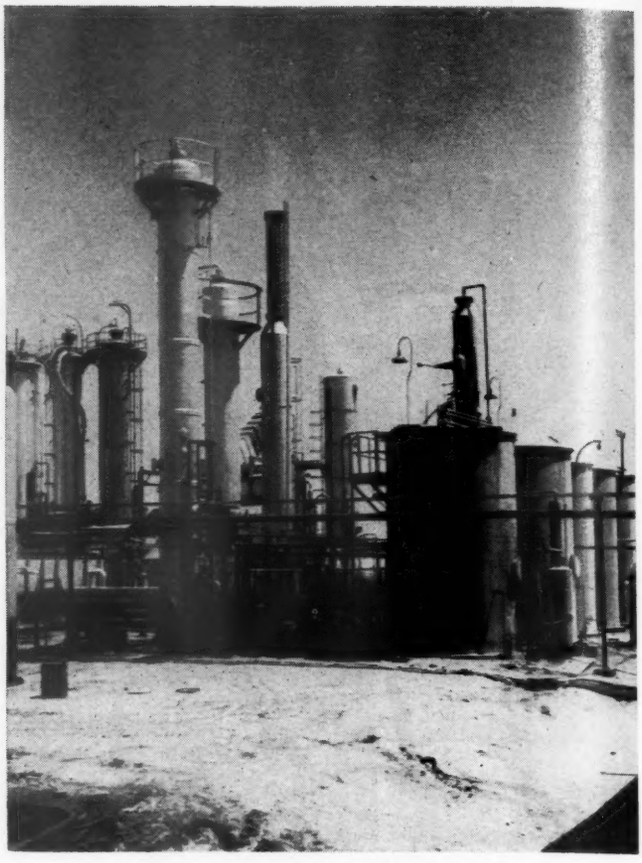
End view of treating plant.



Pressure distillate treating system.

Production Line Treating Established

Modernization of treating systems is made at Fletcher Oil refinery to handle pressure distillate in logical sequence.

J. C. ALBRIGHT

FLETCHER OIL COMPANY'S refinery, at Wilmington, California, has recently been overhauled to install new equipment and to revise certain phases of the processes. When this Universal Oil Company, Dubbs cracking plant was put into initial operation, it was designed to crack kerosine distillate at an average rate of 2500 bbl per day. Improved methods, techniques and auxiliary equipment now permit a daily refining throughout of approximately 5000 bbl without crowding. Current operation is on a blended crude that produces approximately 2750 bbl per day of end-point pressure distillate, a side cut of stove oil, and the conventional fuel oil bottoms. As the production of pressure distillate at the present time exceeds the entire throughput charge of the cracking plant when first designed, the facilities included in the original lay-out were not adequate to treat the gasoline, the entire treating plant has been enlarged and improved.

Throughout the years that this plant has operated, the types of charging stock ran the gamut from kerosine distillate through various types of topped and blended crudes, the stabilizer overhead was sent directly from the column accumulator-receiver to the tank farm rundown storage. Within a few hours, or during the day after the distillate was manufactured, it was again picked up and pumped through the treating plant to extract phenols and mercaptan sulfur. The time lag between production and treating did not improve subsequent motor fuels, and the reaction taking place during this time required a

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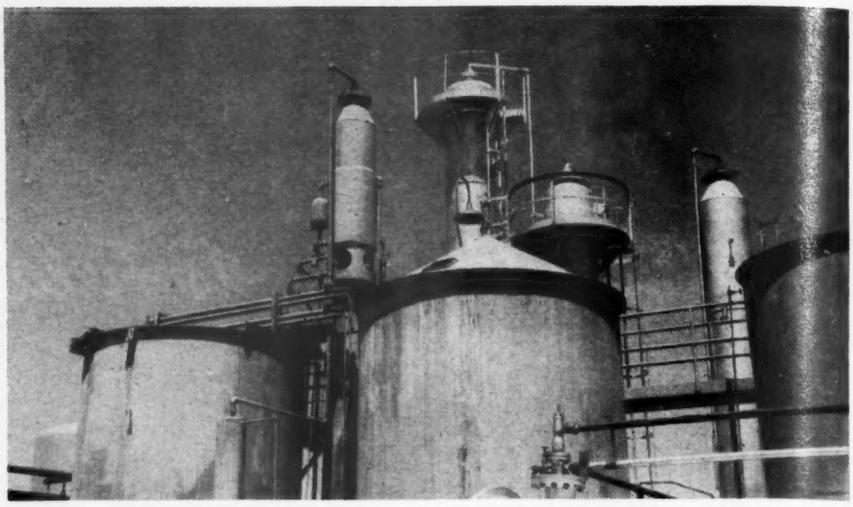
greater quantity of chemicals to remove the contaminants. Phenols and mercaptan sulfur were removed in a single step, and the result was that the spent caustic could not be processed economically to produce either of the contaminants in a relatively pure state. Therefore, the spent caustic was hauled to the harbor of Los Angeles by tank truck, transferred to barges and dumped far out at sea.

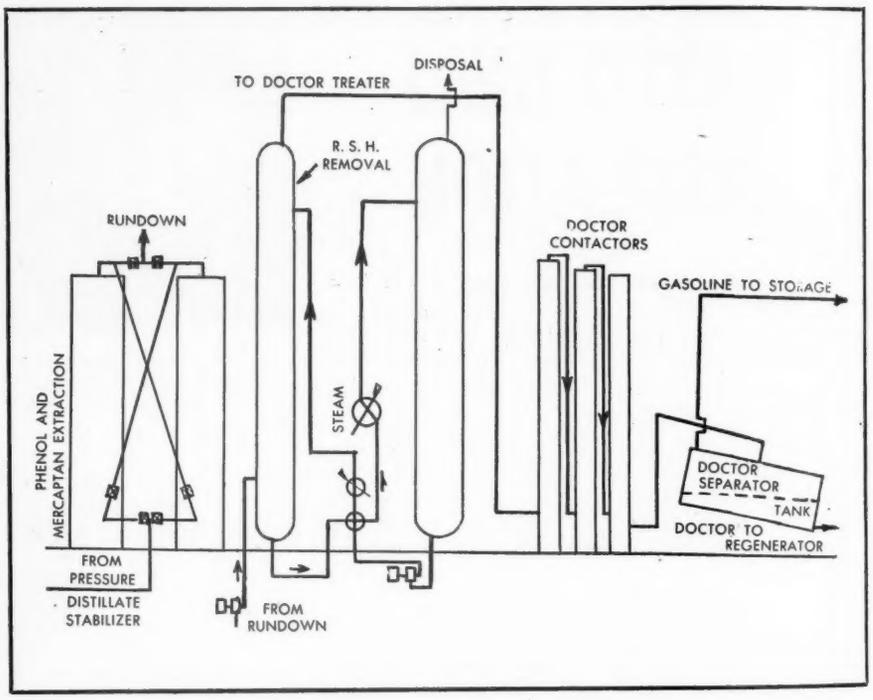
When the plant was overhauled, improvements were made in the pressure distillate stabilizer to fractionate all of the hydrogen sulfide from the bottom product. Final extraction of H_2S from the overhead product is accomplished in a Girdler amine unit, doubled in capacity to treat gases processed in the UOP catalytic polymerization plant. Following this practice of eliminating H_2S in the stabilizer, the pressure distillate is more stable and can be subsequently treated to extract phenols and the mercaptans to keep these two materials relatively pure for future processing.

At the time the gasoline treating plant was overhauled, enlarged and additions made to existing equipment, two similar columns were made available as pre-scrubbers. The function of this prescrubbing operation is to extract the phenols from the pressure distillate before absorbing the mercaptans in a following operation. The phenol extraction section is equipped with piping and manifolds so that the process is in series, the gasoline flowing through both columns. But the piping is arranged so that either of the two columns can be changed instantly to the lead tower, with the other as the following column, but not reversing the flow through either tower. Series operation is used so that the lead column can absorb phenols to the capacity of the chemical employed, and at the same time replacing any mercaptans that may be extracted when the chemical was freshly charged to the column. Caustic with Bé. gravity of 20 deg is used throughout the plant so that one grade of solution can be used for all processes, and to eliminate the use of more than one caustic storage tank.

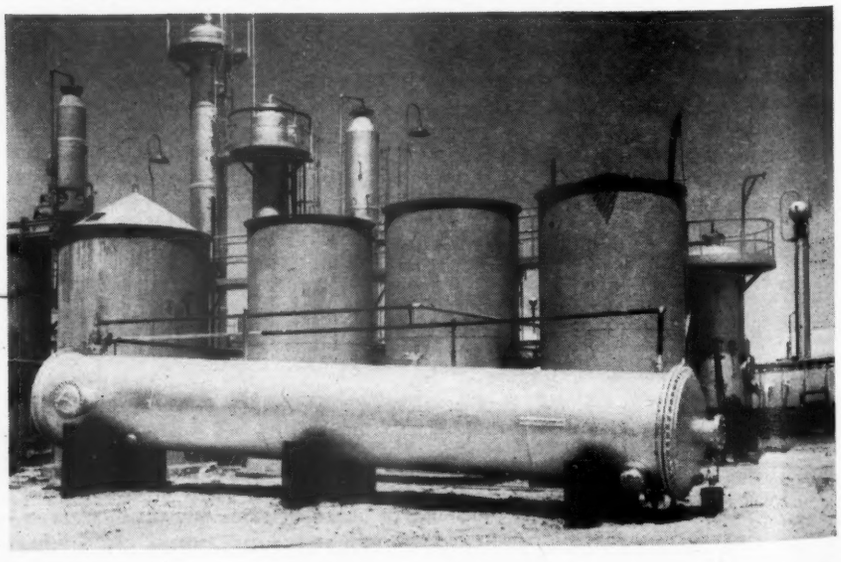
The charge of caustic solution to the prescrubbing, or phenol extraction columns is approximately 365 gal each, and the lead, or tower of first contact is continued on stream until the phenol content approaches 30 per cent saturation. It has been observed that, in this treating plant, when the phenol content reaches this point of saturation, all of the mercaptans have been driven from the solution by a sort of selective absorption process. When this point has been reached, the manifold is changed so that gasoline enters the other column and passes out



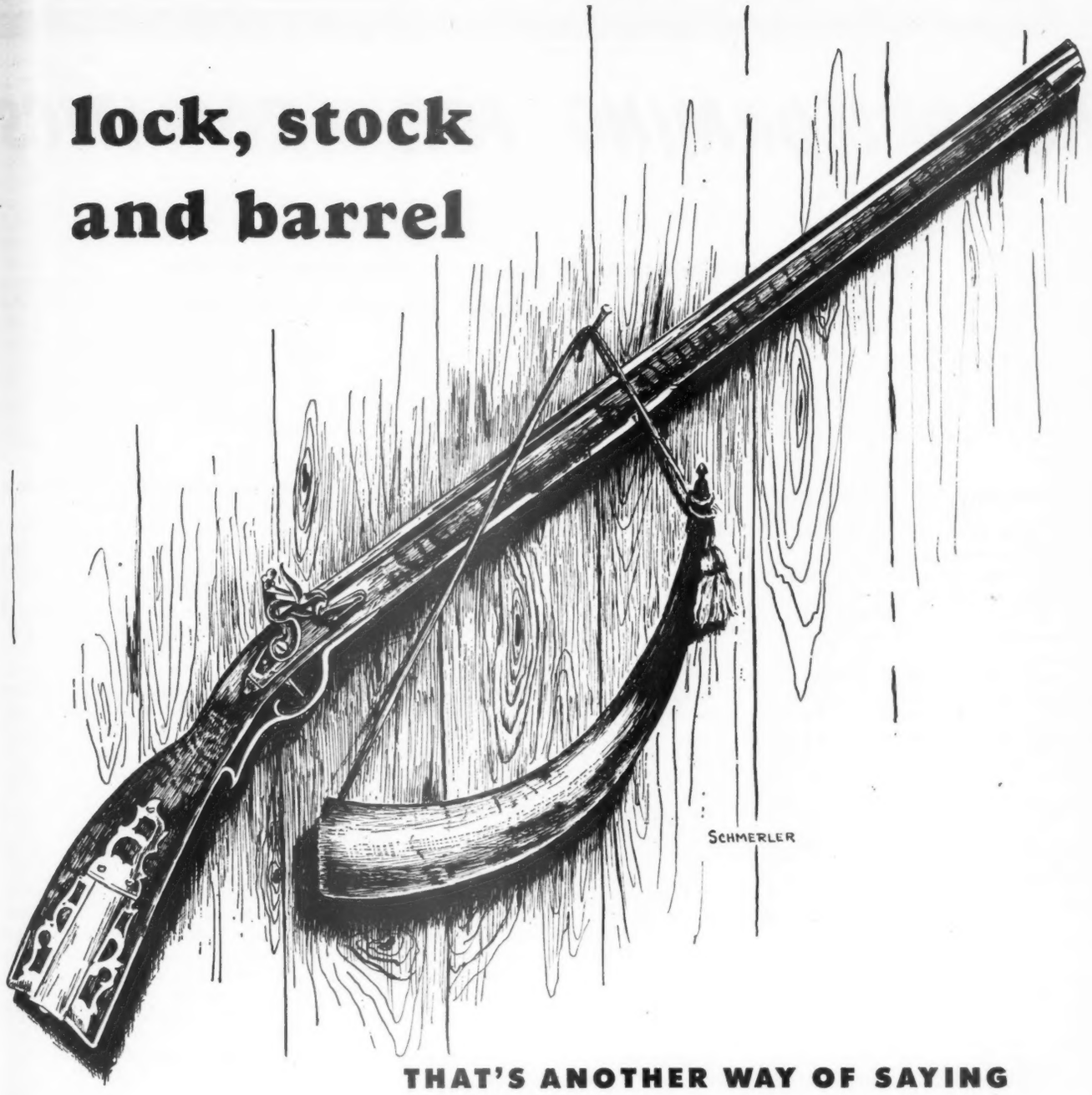
Vapor recovery system on doctor plant of Fletcher Oil Company.



Doctor solution and gasoline separator in refinery at Wilmington.



lock, stock and barrel



THAT'S ANOTHER WAY OF SAYING UOP SERVICE IS COMPLETE

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HOUDRIFORMING FOR AROMATICS

Pilot unit data show how to process various charge stocks for benzene, toluene, C_8 concentrates, high octane gasoline.

H. HEINEMANN,* J. W. SCHALL,* D. H. STEVENSON*

HOUDRIFORMING is a catalytic reforming process applicable to the production of both aromatic concentrates and high octane motor gasolines from petroleum naphthas. Thermal and catalytic reforming of straight run naphthas have been subject to many developments in the course of the last 20 years. Thermal reforming adequately met the relatively low octane requirements prevailing in the past. As octane requirements have increased, however, thermal reforming has suffered largely from volume losses of liquid hydrocarbons to gaseous hydrocarbons. Catalytic reforming has been practiced mostly in the form of fixed bed hydroforming, a process that involves operation at elevated pressure and with cyclic regeneration, requiring constant pressuring and depressuring of reaction vessels. Only recently have reforming processes been developed that permit the production of high octane number gasolines at high yields in a continuous operation requiring no regeneration or infrequent regeneration if operated at very severe conditions.

Houdriforming is a continuous catalytic reforming process. The reactions occurring in Houdriforming a naphtha charge are selective and consist predominantly of dehydrogenation, isomerization, aromatization, hydrocracking, and desulfurization. Dehydrogenation and dehydroisomerization of naphthenes permits the production of aromatic concentrates such as benzene, toluene, and xylenes from naphthene-rich naphtha fractions. The same reactions plus isomerization of paraffins and aromatization of paraffins result in high yields of high octane motor gasoline from straight run naphtha fractions. In the production of both aromatics and high octane motor gasoline, hydrogen is produced with good purity as a by-product of the process. The process is continuous at normal operating severity but, at conditions of extreme severity, periodic regeneration of the catalyst to remove coke may be necessary.

Several pilot units have been operating for the last two years at the Houdry laboratories to obtain data on Houdriforming various charge stocks. Fundamental process data on pure compounds are obtained from isothermal reactor units. Actual processing data on typical naphthas are obtained with multiple reactor units in which the reaction is allowed to proceed adiabatically in each reactor to simulate proposed commercial operation. The number of reactors operated in series can be varied to give the desired results when processing different charge stocks. As the major reaction is endothermic, interstage reheaters are provided between reactors to reheat the reactor effluent and thus supply the endothermic heat of reaction. Recycle hydrogen is separated from the liquid product in a simple gas separation tank at run pressure and room temperature and is compressed and charged along with the hydrocarbon feed. The hydrogen content of this stream varies from 86 to 98 per cent, depending on the charge stock and operating conditions used. The quantity of recycle hydrogen is regulated so that a sufficient partial pressure of hydrogen is maintained to prevent or minimize coke deposition on the catalyst.

*Houdry Laboratories, Houdry Process Corporation Marcus Hook, Pennsylvania.

Houdriforming of Pure Compounds

The primary reactions occurring in Houdriforming and contributing to the upgrading of the charge stock are the dehydrogenation of C_6 ring naphthenes, the dehydroisomerization of alkyl cyclopentanes and the conversion of paraffins by isomerization, hydrocracking, and aromatization. In normal operation it is obviously impossible to follow completely each one of these reactions because of the complexity of the feed stock and the interaction of hydrocarbons in the feed stock.

In experimental units it is possible to charge pure compounds and to analyze reaction products for the individual compounds formed. In this way, it is possible to follow the transformation of hydrocarbon classes within certain limitations. The conclusions resulting from such pure compound work, of course, are not entirely applicable to mixed feed stocks. In the latter case there is competition between the various types of hydrocarbons for the active sites of the catalyst. Due to preferential adsorption of certain types of hydrocarbons on the active sites, these sites may be denied to other types of hydrocarbons with a resulting suppression or reduction in the rate of specific reactions. Even so, it is interesting to note the extent to which pure hydrocarbons react. The processing of pure hydrocarbons offers a good means of testing catalyst activity for specific reactions.

Table 1 shows the conversion of cyclohexane to benzene over a typical Houdriforming catalyst at 300 psig pressure, a hydrogen to oil molar ratio of 4, and three different severities obtained by changing temperature and space rate. Comparison with equilibrium conversion under the same conditions shows that equilibrium was essentially reached at each level of severity.

Methylcyclopentane is the most difficult of the alkyl cyclopentanes to dehydroisomerize. Its conversion to benzene therefore constitutes a severe test for catalyst activity. If one disregards side reactions such as cracking or ring splitting, methylcyclopentane will be converted to benzene in yields corresponding to 80-90 per cent of the calculated thermodynamic equilibrium yields. Due to the uncertainty in the calculation of equilibrium values, the reaction must be considered as proceeding essentially to equilibrium. This dehydroisomerization is relatively slow and yields approach equilibrium as space rate declines. The amount of cracking occurring is, of course, influenced by operating conditions and also by the amount and nature of other compounds present.

TABLE 1. Houdriforming of cyclohexane.

300 psi; H_2:Oil = 4 Moles	Cyclohexane→Benzene conversion, %	
Severity	Found	Equilibrium value
1.....	50	55
2.....	70	74
3.....	92	94

Normal heptane can be chosen as a typical paraffin stock for Houdriforming operation. Wide variations in product distribution can be obtained by changing catalyst composition and operating conditions. At mild operating conditions, approximately 9 per cent aromatics, mostly toluene, are obtained from normal heptane. The molar ratio of iso to normal paraffins in the C_7 fraction of the product is approximately 1.5. At more severe conditions the aromatics content will increase to about 15-16 per cent and the iso to normal ratio of C_7 fraction will increase until hydrocracking of the isoparaffins formed becomes the predominant reaction. The most favorable operating conditions must therefore be selected on the basis of products desired (aromatics or isoparaffins).

Houdriforming for Aromatics Production

The petroleum industry is currently faced with the problem of alleviating the critical shortage of benzene, toluene, and xylenes needed for the defense effort and for the expanding chemical and plastics industries. The reactions promoted by a Houdriforming catalyst can be applied to closely cut naphtha fractions for the production of these specific aromatics. The charge stock to such an operation may include a combination of benzene, toluene, and xylene formers, or it may be so fractionated as to include formers for only one of these aromatics. The choice of naphthenes to include in a charge stock will depend, in part, on the type of charge stock, the desired yield of specific aromatics, and the separation scheme to be used. Best yields of aromatics will be obtained by running closely cut fractions resulting principally in the formation of only one of the aromatics. Economic considerations will in certain cases favor an operation, however, in which a blend of aromatic formers is charged.

TABLE 2. Houdriforming a C_6 fraction for benzene production.

Debutanized liquid, vol per cent chg.	87.9
C_4's, vol per cent	2.6
Propane, wt per cent	0.9
Ethane, wt per cent	0.6
Methane, wt per cent	0.4
Hydrogen, wt per cent	3.4

Analysis: vol per cent	Charge	Debutanized liquid
Benzene	2.7	51.2
Toluene	—	3.9
Methylcyclopentane	56.7	13.0
Cyclohexane	27.4	1.1
Heavier naphthenes	—	0.8
Olefins	—	1.8
Paraffins	13.2	28.2

TABLE 3. Houdriforming a C_6-C_7 fraction for benzene and toluene production.

Debutanized liquid, vol per cent chg.	89.3
C_4's vol per cent	2.6
Propane, wt per cent	1.1
Ethane, wt per cent	0.3
Methane, wt per cent	0.2
Hydrogen, wt per cent	2.7

Analysis: vol per cent	Charge	Debutanized liquid
Benzene	1.4	15.6
Toluene	4.6	31.7
Methylcyclopentane	4.6	2.8
Cyclohexane	13.9	0.8
Dimethylcyclopentanes	9.6	3.0
Methylcyclohexane	23.1	0.3
Olefins	—	0.9
Paraffins	42.8	43.1

TABLE 4. Houdriforming C_8 fractions for aromatics production.

C_5^+ liquid vol per cent chg.		91.1		87.1
C_4's vol per cent		1.8		3.6
Propane, wt per cent		0.9		1.3
Ethane, wt per cent		0.4		0.8
Methane, wt per cent		0.2		0.8
Hydrogen, wt per cent		2.1		2.2
Analysis: vol per cent	Charge	C_5^+ liquid	Charge	C_5^+ liquid
Toluene	—	5.4	—	2.5
C_8 aromatics	1.9	30.3	8.0	40.9
C_9 aromatics	1.1	5.1	—	18.4
Naphthenes	42	2.0	61	2.0
Olefins	—	2.0		2.0
Paraffins	55	55.2	31	34.2
F-1 Octane No. (Total C_5^+ liquid)				94.3
F-4+4.6cc TEL Aviation blending P. N. (aromatic portion)	190			220

TABLE 5. Houdriforming naphthas for motor gasoline production.

Charge stock	A		B		C	
C_5^+ liquid, vol per cent chg.		85.8		84.3		86.6
C_4 cut, vol per cent		5.2		7.2		6.1
Propane, wt per cent		2.9		4.0		3.0
Ethane, wt per cent		1.7		1.8		1.8
Methane, wt per cent		0.9		1.0		0.7
Hydrogen, wt per cent		1.3		0.8		0.6
Inspections of C_5^+ liquid	Charge stock		Charge stock		Charge stock	
Gravity, °API	55.3	48.2	52.7	44.1	51.6	47.1
Distillation, ASTM, F						
I.B.P.	188	148	238	152	220	138
10 per cent	215	200	266	224	247	208
50 per cent	252	254	300	286	286	274
90 per cent	317	326	358	354	354	358
E.P.	368	385	396	438	396	438
Octane numbers						
F-1 clear	55.6	89.1	42.5	90.3	51.5	90.2
F-1+3ccTEL/gal	76.3	97.1	65.8	97.4	68.8	97.4
Reid vapor pressure, psi	0.7	2.4	0.7	2.7		3.0
Chemical composition						
Paraffins	44	41	44	40	34	38
Olefins	0	1	1	2	0	2
Naphthenes	42	3	43	1	52	5
Aromatics	14	55	12	57	14	55

The results of processing a closely fractionated naphtha containing only C_6 hydrocarbons are presented in Table 2. This stock, because of its high content of methylcyclopentane (56.7 vol per cent), presents a rigid test material for an aromatics producing catalyst. In a once-through operation, a debutanized product containing 51.2 vol per cent benzene and 3.9 vol per cent toluene was obtained. Higher conversion of the naphthenes is possible by increasing the severity of operation, however, the conversion efficiency (defined as,

$$\frac{\text{naphthenes converted to aromatics}}{\text{naphthene disappearance}}$$

is markedly reduced. The most efficient conversion of naphthenes would be obtained with a recycle operation at sufficiently mild conditions to keep side reactions negligible.

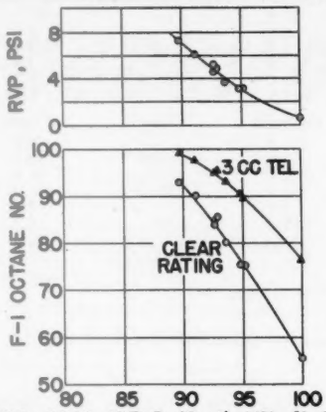
Another typical naphtha, fractionated to contain only benzene and toluene formers, was processed and the results are presented in Table 3. In a once-through operation a debutanized product containing 15.6 vol per cent benzene and 31.7 vol per cent toluene was obtained. This yield of aromatics represents approximately 90 per cent total conversion of naphthenes to aromatics. This high conversion of naphthenes was accomplished with very little loss due to side reactions. Approximately 1300 SCF/bbl of 98 vol per cent hydrogen is produced as run gas from this charge stock. As no CO or CO_2 is present in this hydrogen, it is a more useful product for most purposes than hydrogen of similar or higher purity obtained in a hydrogen plant using a water gas shift reaction.

Houdriforming is also applicable to the production of C_8 aromatics for use as chemicals or in aviation gasoline blending stocks. Table 4 presents data obtained from processing two different fractions containing predominantly C_8 hydrocarbons. The first stock contained 42 vol per cent naphthenes and yielded a product containing a total of 40.8 vol per cent aromatics. The aromatics when separated from the liquid product had an aviation blending performance number of 190 (F-4+4.6cc TEL). The second charge stock shown in Table 4 contained considerably more naphthenes (61 vol per cent and yielded a product containing 61.8 vol per cent aromatics. The aromatics from this product had an aviation blending performance number of 220 (F-4+4.6cc TEL). In both cases very little hydrocracking occurred as evidenced by the low yields of butanes and lighter hydrocarbons.

Houdriforming for Motor Gasoline Production

High yields of high octane motor gasoline are obtainable from straight run naphthas. Fig. 1 presents the Reid vapor pressure, octane number and yield of C4+ motor gasoline obtained when processing an East Texas type naphtha. The data presented were ob-

FIG. 1. Octane number and RVP of stabilized gaso. as functions of yield.



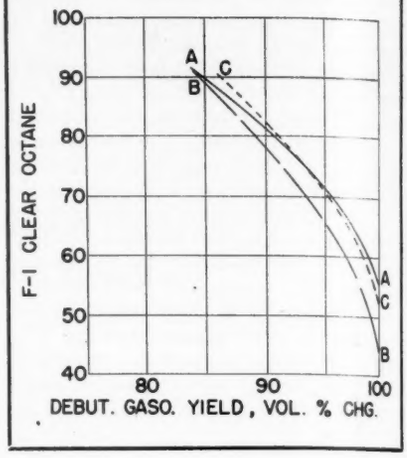
tained by varying space rate and temperature at a constant pressure and recycle gas to oil mole ratio. A 93 F-1 clear octane gasoline with a Reid vapor pressure of 7.2 psi was obtained at a yield of 89.7 vol per cent. Under all of the conditions used to obtain the data in Fig. 1, outside butanes are required for 10 lb RVP gasoline.

More detailed data for an East Texas type naphtha and two other naphthas are presented in Table 5. Inspections of the charge stock, and yields and inspections of the C_5+ product are presented. At the 90 F-1 clear octane level, the yields of C_5+ product for the three stocks range from 84.3 to 86.6 vol per cent, with yields of butanes ranging from 5.2 to 7.2 vol per cent. In all cases there is an increase in ASTM distillation end point of the product over that of the charge. However, this increase is to be expected when converting naphthenes to the corresponding aromatics.

The yield of C_5+ product vs F-1 clear octane number for each of the three stocks is presented in Fig. 2. Although beginning at different octane levels, each of the stocks yields approximately the same volume per cent gasoline at the 90 F-1 clear octane level. The curves as shown in Fig. 2 show no sharp decrease in yield for a given octane improvement. It must be expected that a sharp break in the curve will occur at some point because of excessive hydrocracking. Excessive hydrocracking, however, was not encountered at any condition of severity used in processing these charge stocks. The hydrogen content of the run gas and recycle gas for these operations varied between 86 and 96 vol per cent depending upon the severity of operation. It is of interest to mention that the data presented for motor gasoline production were obtained with catalysts having previous continuous operating histories of from 800 to 1400 hours and therefore represent performance of well aged catalyst.

High yields of benzene, toluene, or xylenes are possible from the Houdriforming of close cut naphtha fractions. Conversions of naphthenes to aromatics of up to 95 per cent of equilibrium are obtained along with large quantities of 98 vol per cent purity hydrogen. Low octane straight run naphthas can be processed to high yields of high octane motor gasoline. Data presented for a few feed stocks show yields of debutanized motor gasoline up to 86.6 vol per cent of charge when processing to the 90 F-1 clear octane level. * * *

FIG. 2. Yield-octane relationship for Houdriforming various naphthas.



Maintenance of Heat Exchange Equipment†

J. H. FITZPATRICK*

One of the most important functions in present day maintenance is that of heat exchange equipment. In all plant operations, whether it be in a refinery with hundreds of units in operation, whether it be in the average industrial plant or in private and public utility, the need for planned maintenance is essential to realize the maximum heat transfer rate that naturally increases output because higher capacities can be realized from the greater rate of that heat transfer.

Heat exchange equipment for the purpose of this discussion refers generally to tubular equipment and is classified as shell and tube exchangers, kettle elements, overhead condensers, surface condensers, vaporizers, and cooling tower coil sections.

In using the term heat exchange maintenance one naturally thinks of the cleaning of equipment, which is directly the purpose of this discussion.

To attain that speed and thoroughness for the most economic and efficient procedure in the cleaning of a unit or group of units, it is necessary to select the technique or combination of techniques that will give the desired results.

In order to determine the proper method for cleaning, it is necessary to take into consideration various factors. (1) The type of deposit; (2) the overall time required for the job or the allowable outage time, and (3) the cost.

The types of deposits may be broken down into three classifications according to their detrimental effect.

(1) Hard deposits: Formed by water scales, corrosion products, rust, hard coke, etc.; (2) porous deposits: Formed by mud and dirt precipiated out from water or oil, coke or carbon, asphalt or other like substances; (3) loose deposits: Formed by mud and silt, soot, powdered coke, vegetable matter, polymers, slimes and other process fluids.

The loose deposits have been considered to be the most detrimental to heat transfer due to the fact that the character of the deposits will change with age and the temperature to which they are subjected. For this reason a universal cleaning procedure has never been perfected.

Types of Cleaning

Chemical cleaning in the last few years has become a major maintenance tool due largely to accessibility of the fluid to all parts of a unit, the outage time involved when cleaning a large vessel or group of vessels and the actual dollar and cent cost when compared to outage time and man hours for maintenance. Twenty or more units may be as easily cleaned as one, with only the additional time required for the filling of the units which would be negligible. Chemical cleaning should never be attempted except by trained personnel.

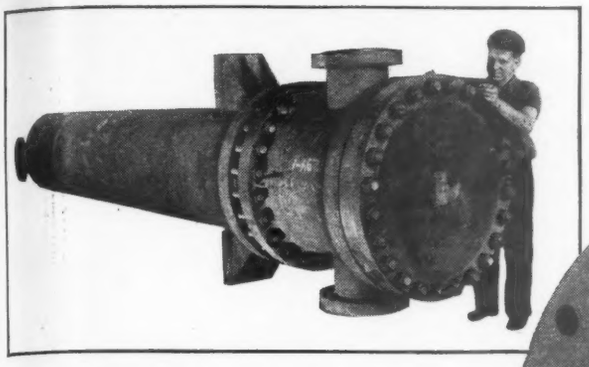
It should be pointed out that it is not necessary to remove the tube bundle or disturb the unit to effect a chemical cleaning.

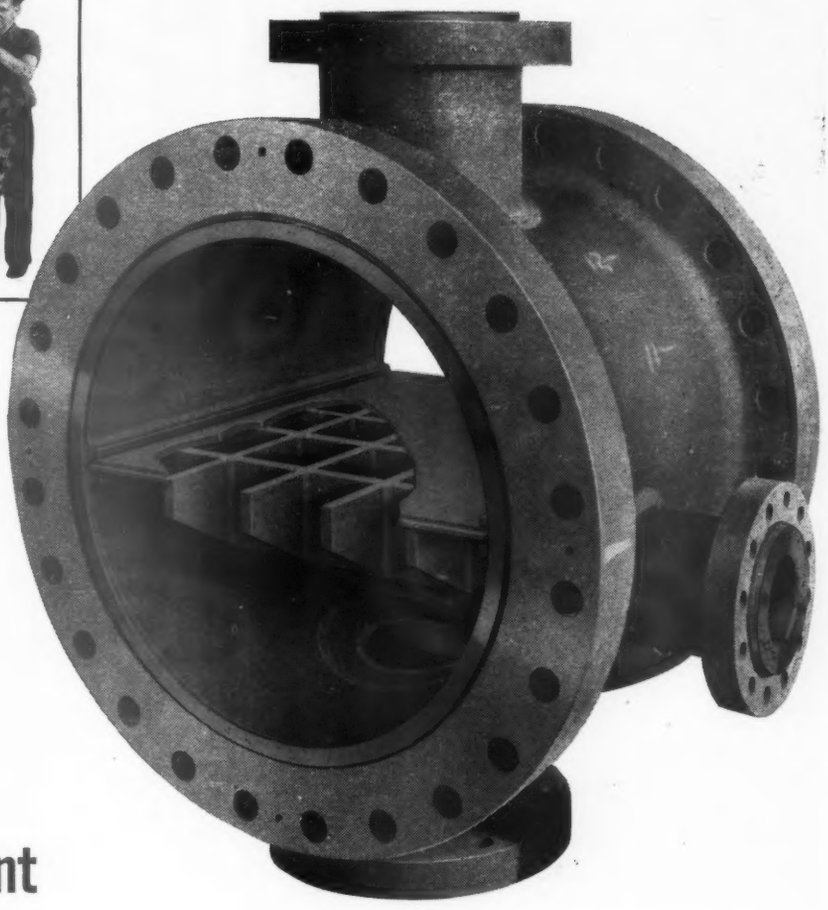
Wet sand blasting has been found effective when scales are insoluble or have limited solubility. Cleaning is accomplished by jetting with high pressure water or with high pressure water and abrasives. Aspirating nozzles which discharge aerated water to remove soft to medium hard deposits and aerated water plus abrasives for harder deposits are available.

Dry sand blasting is used on the tube side of bundles when extremely hard deposits are encountered. Blasting time is held to the minimum necessary for complete removal of deposits. Here again the necessity is shown for trained personnel to properly handle the nozzle to minimize loss of metal due to impingement of abrasives. * * *

†Condensation of a paper given before the California Natural Gas Association, fall meeting, October 4 and 5, Los Angeles, California.

*International Cementers, Inc.





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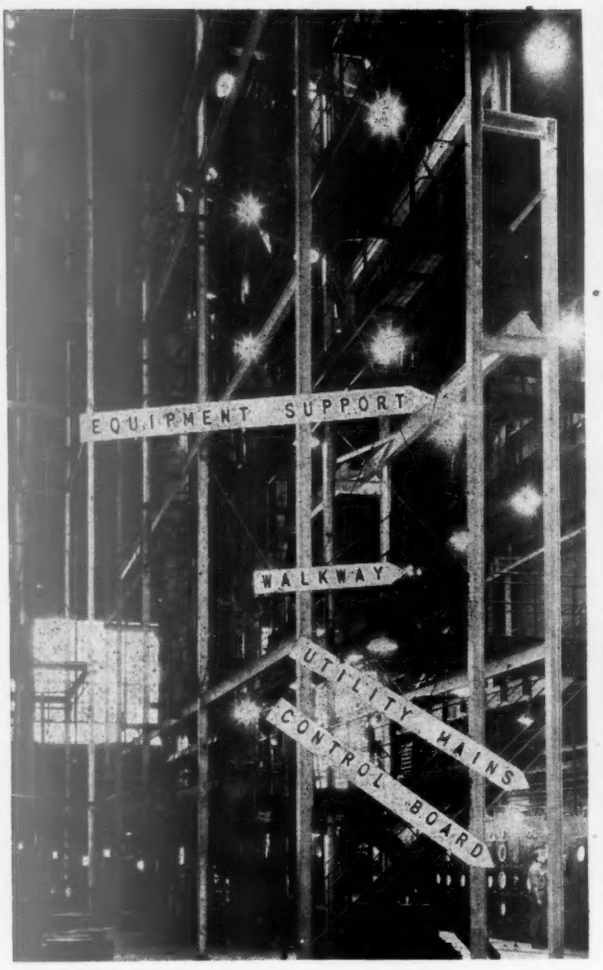
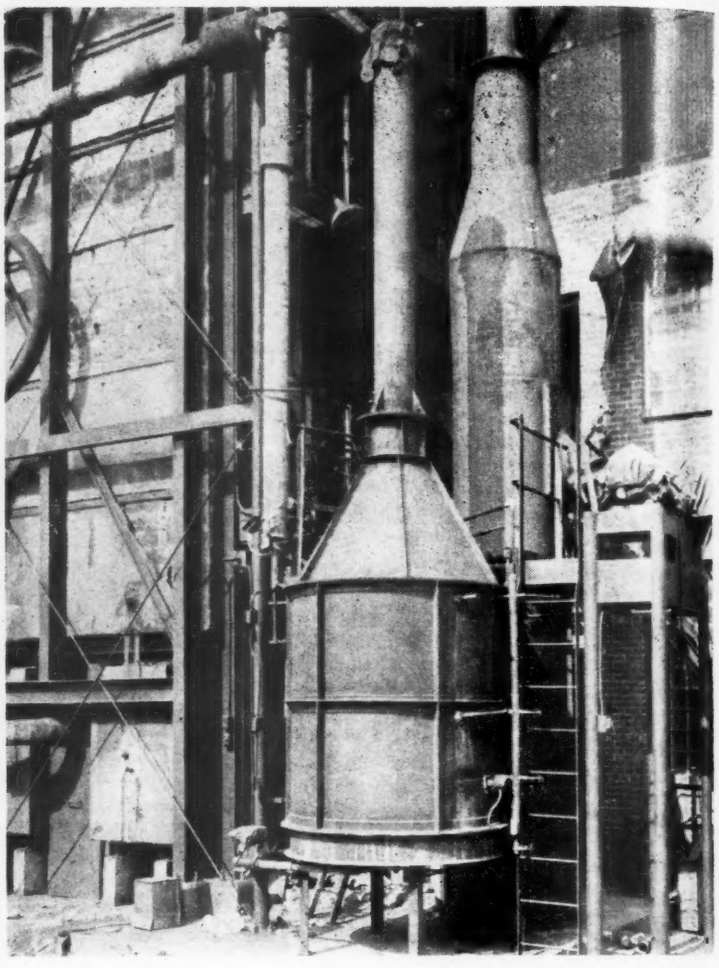


General view of pilot plant area.



Standard helical coil furnace.

Short Cuts in Pilot Plant Engineering†

J. C. REARICK*

Abstract

A major problem in the design and construction of pilot plants is that of keeping engineering costs in proper proportion to the total without sacrifice in performance of the completed plant. The organization of a closely coordinated group responsible for such work and the development of standardized designs have been found helpful in solving this problem.

*Development Engineer, The M. W. Kellogg Company.

†Presented before the Petroleum Mechanical Engineering Conference, Tulsa, Oklahoma, September 24-26, 1951 of The American Society of Mechanical Engineers.

THE petroleum industry has had a leading role in the development of continuous process pilot plants, and these in turn have contributed in no small measure to advances in refining technology. The two major fields of pilot plant utility are development of new processes and evaluation of the effect of changes on existing processes. In the former category, pilot plants are used to bridge the gap between laboratory and plant, to determine the effect of operating variables and to obtain engineering data necessary for the design of full scale units. Where the process is already in commercial operation, the pilot plant makes it possible to study the effect of change in feed stocks, and operating conditions or to predict the result of equipment modifications at reduced cost and without loss of production on the process unit. Where a new plant must be built for a known process, the pilot plant will furnish the design information necessary to adapt the process to the feed stock or other conditions peculiar to the specific job.

To be useful for any of these purposes it is essential that the results obtained from the operation of the pilot plant be representative of the performance of the full scale unit. This particularly is true in the case of the engineering contractor who may be required to guarantee the performance of a commercial plant on the basis of such data. Consequently

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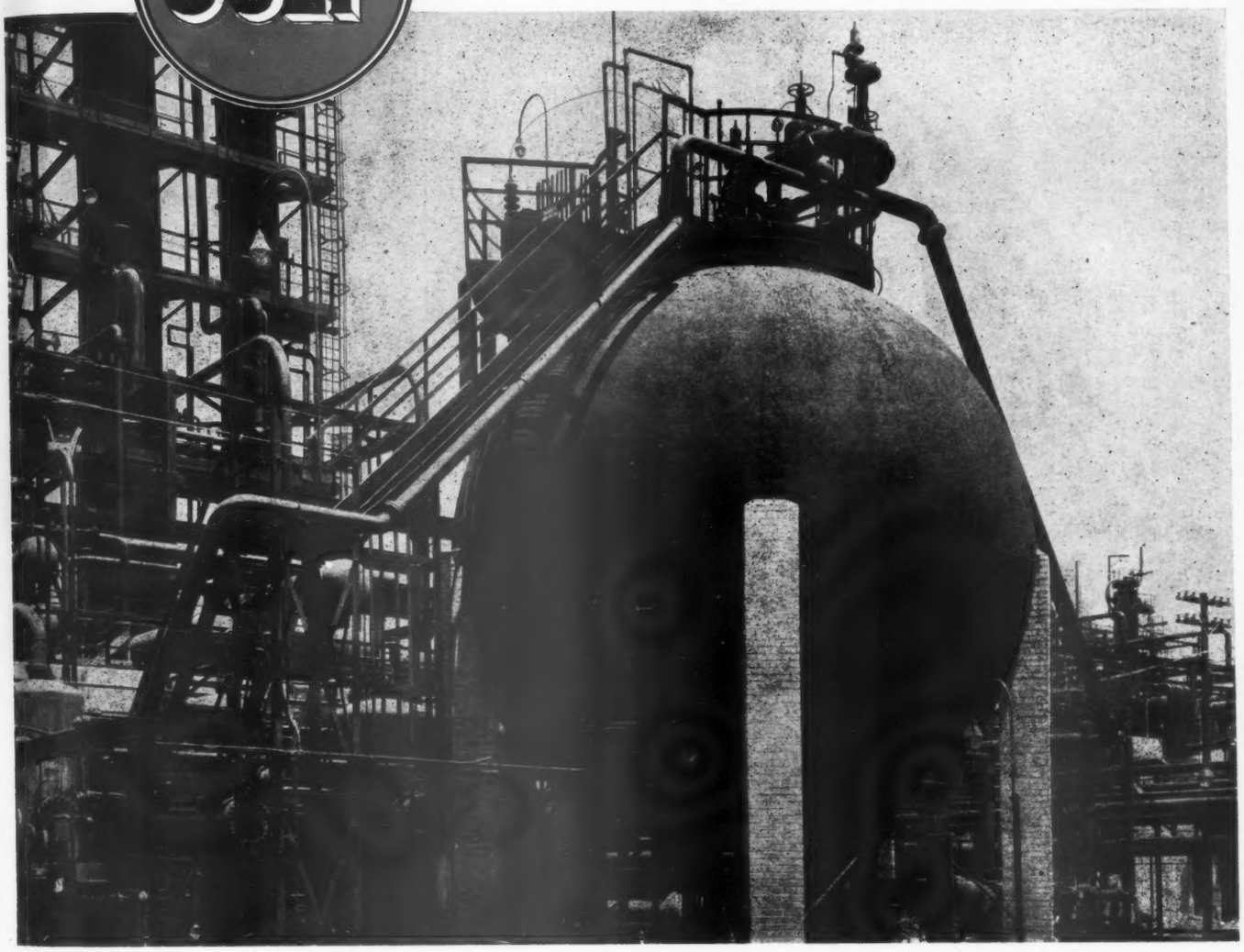

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the pilot plant must be carefully engineered both from a process and from a mechanical standpoint. Since practically all of the elements of the large plant may be found in the pilot unit, engineering costs become excessive if carried out in the same detail as for a full scale installation. It is the purpose of this paper to describe some engineering "short cuts" which have proved successful in holding such costs to a minimum.

Process Design

Although this discussion is concerned primarily with mechanical design, the process design is closely related and merits brief consideration in this connection.

There are a number of differences between the design of pilot and full scale units. In general, the commercial plant is designed to operate at a specific capacity on a specific feed stock and to produce specific products of specific quality. The pilot plant on the other hand, must be designed to operate over a wide range of conditions on a variety of feeds; capacity *per se* is of little importance; and economy of heat or utilities does not generally have to be considered. For an existing process the range of conditions will be fairly well established, but for a new process, the designer is usually working in unknown territory guided only by more or less sketchy laboratory data. He must frequently transpose batch data to continuous operation, predict the effect of recycling, and make similar extrapolations.

Regardless of the purpose of the pilot plant, it is highly desirable to first attempt to visualize the full scale plant and then to scale the latter down to the pilot size. Although at first glance this might seem to be a reverse procedure in the case of a new process, it is actually not, since the function of the pilot plant is to predict the operation of a full scale unit and failure to consider the latter in the design, may result in a pilot unit which will not produce data applicable to any larger scale.

Pilot plant design inevitably involves some degree of compromise inasmuch as is impossible to scale up or down without some change in relationships. It is the joint responsibility of the process and mechanical designers to insure such changes do not impair the validity of the data produced.

The importance of the application of principles of similitude to pilot plant design has been pointed out frequently in the past. Unfortunately, however, the relative importance of the various factors affecting the process under consideration usually has not been firmly established and generally it is not feasible to adopt the devices which have been proposed to achieve similitude where more than one physical process is controlling.

The problem is further complicated by the fact that scale factors of several thousand to one are not unusual. The designer must therefore make a thorough study of the available data for the particular process and attempt to estimate the relative importance of the physical and chemical factors affecting it. In this phase of the design it is of the utmost importance that there be close cooperation between the process and mechanical designers in order that the process requirements will be met in a mechanically feasible design.

The Author

John S. Rearick reached his present position as development engineer with M. W. Kellogg Company through graduation from Hamilton College (1929), master's degree in chemical engineering in 1930 from Columbia University; more graduate work at Columbia in 1932, along with interim junior engineer with the Dorr Company, and chief chemist of Columbia Refining Company in Jersey City, from 1933 to 1937. Going to Kellogg's Jersey City laboratories as supervisor in 1937, he became successively assistant director of petroleum research, director of research and associate director of petroleum and chemical research laboratories, from which job he was made development engineer earlier in 1951.

During this period he has devoted his energies mainly to pilot plant operation, design, and construction, design of laboratory facilities in general, and to mechanical and process developments in these fields.

Organization

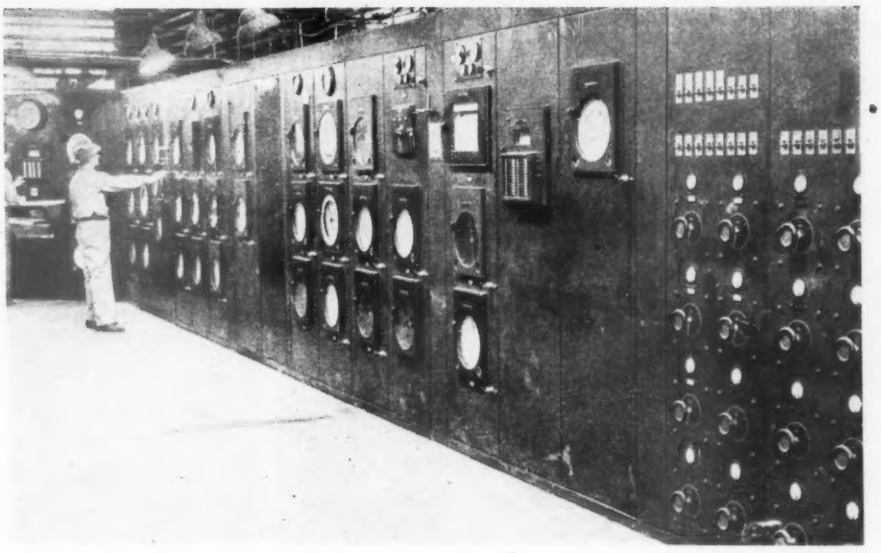
A major factor in the success or failure of a pilot plant program is the skill and thoroughness employed in the mechanical design of the unit. Pilot plant operations are costly and much time and money may be lost as a result of mechanical inadequacies of the equipment. Here again compromise is necessary to produce a satisfactory plant at a reasonable engineering cost. The guiding principles which were used in attacking this problem might be expressed as: Continuity, coordination, and standardization.

By assigning one individual to each project to follow it from the initial stages of design to final completion of construction, much of the lost motion involved in relaying information was eliminated; by close coordination between process design, fabrication and construction personnel the amount of detail required was greatly reduced; by developing standard designs and details for certain types of equipment, drawings could be used repeatedly with, at the most, minor changes or additions.

It was found desirable to set up a group specifically charged with the responsibility for designing and constructing pilot plants. It consists of three major sections: Design, mechanical, and machine and instrument, all reporting to the laboratory engineer. The members of the design section are preferably graduate engineers with an aptitude for this type of work who have had previous experience in pilot plant operation. They must possess a rather high degree of versatility in order to handle the various assignments involved. The section is normally small and is expanded when necessary by the addition of junior men, usually drawn from other sections of the laboratory. It is responsible for all design work and also furnishes general and facilities engineering services to the laboratory as a whole. The mechanical section is responsible

Coil winding machine.

for all maintenance and construction work within the laboratory, including fabrication of special equipment. It is headed by the mechanical supervisor under whom are the various craft foremen and mechanics. Many of these men also have had prior experience in the operating group. The size of this section is subject to considerable variation depending on the work load, but by maintaining a nucleus of thoroughly trained men considerable expansion is possible without serious loss in efficiency. When the size of the group is at a minimum, the craft foremen become working foremen; when at a maximum, their duties are entirely supervisory. The machine and instrument section handles calibration, maintenance and repair of all instruments, and such machine work as is carried out within the laboratory organization. It is also custodian of various items of equipment salvaged from dismantled pilots and reconditioned for future use.



Control board.

Procedure

The operation of the system can best be illustrated by following the course of the design and construction of a pilot plant and pointing out some of the short cuts employed. When it appears desirable, based on preliminary laboratory work, to carry the development into the pilot plant stage, the design section is brought into the picture.

The design engineer to whom the project is assigned is the key man from the first preliminary rough estimate of plant cost until the pilot plant is in successful operation. He participates actively in establishing the process design, carries through all phases of mechanical design, serves as advisor to the mechanical section during fabrication and construction and provides technical assistance within his field during initial operations.

As the first step a tentative process design is established through consultation with the research personnel concerned with the previous laboratory work and the minimum mechanical design work necessary to prepare an approximate estimate is carried out. The amount of such work done at this stage will depend on the accuracy desired in the estimate of plant cost, but generally it is quite limited.

After approval of the project, a final process design is agreed upon through the joint efforts of the research and design personnel. This sets forth the range of operating conditions, heat duties, and capacities; it also includes the dimensions of the major vessels and a general outline of the control scheme to be employed.

The design engineer under the supervision of the head of the design group is completely responsible for all phases of the mechanical design of the plant. In the case of a large project he may have one or more junior engineers assigned to assist him. After the process design has been approved, a detailed flowsheet is prepared showing schematically all process lines, equipment, and instrumentation. Utility lines are generally not shown except for points of connection to the equipment. Where the scope of the job requires it, a separate utility diagram may be prepared. The flowsheet is the most important drawing and serves as key to the entire job. As the design progresses additional information such as line, equipment and instrument designations, etc. is added to it. It is of great value to the operating personnel prior to and during the start-up of the new plant, and a copy is usually mounted permanently at the site. The designations shown on the flowsheet are also placed on metal tags permanently attached to the valves on the plant for ease of identification.

From the flowsheet a list of required equipment is assembled. Any equipment available in storage is checked for suitability and specifications are prepared for that which must be purchased. A rough material take-off is made based on the flowsheet plus previous experience with other plants and the necessary requisitions are issued. It is the practice to maintain a reasonable stock of commonly used materials which serves to balance out any inaccuracies in the take-off.

A plot plan and elevation drawing showing locations of all principal pieces of equipment are next prepared. The first issue of these is of a preliminary nature for guidance in the detailed design of the various vessels, etc.; as such designs are completed, the plot plan and elevation are finalized for use in the erection of the equipment.

The layout of the plant is simplified by the arrangement of the pilot plant area. The principal area occupies a space 60 by 200 ft with a maximum head room of approximately 56 ft. Utility mains are carried around the inside of the boundaries of the area with connections, provided at 20 ft intervals. These include cooling water and return, 100 lb steam, 100 lb air, fuel gas, and 1000 lb N_2. A three phase power bus encircles the area in a similar manner. The reinforced concrete floor is designed to support any anticipated loads and is sloped slightly to transverse drainage trenches at forty foot interyals.

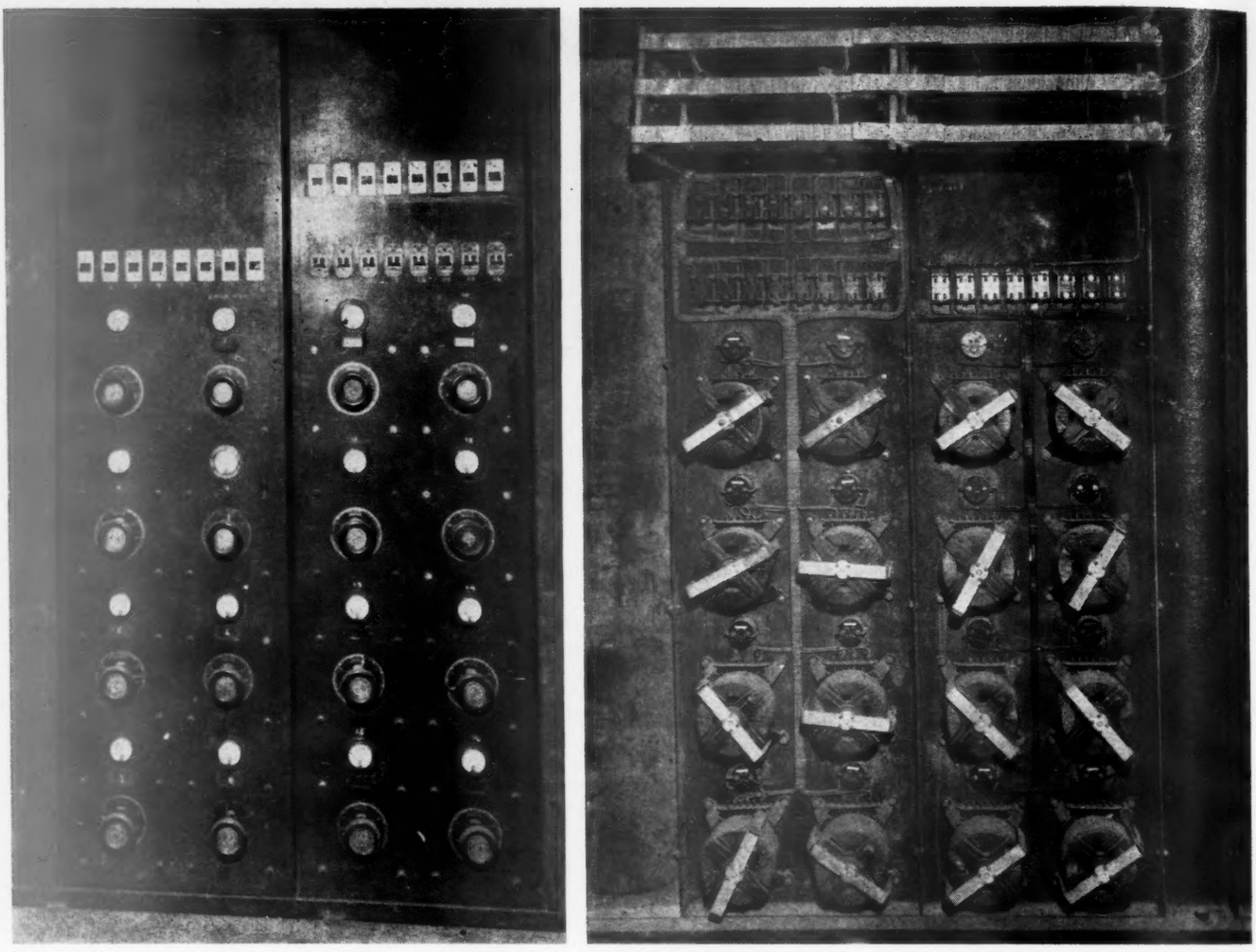
An attempt has been made to standardize on the design of major structural work in the pilot plant area with an eye to permanent utility even though the pilot plants themselves may become obsolete. This design provides considerable flexibility to accommodate vessels of various dimensions, includes the necessary stairs and walkways for convenient access to the equipment, and is used wherever practicable.

Fabricated Equipment

Numerous short cuts are employed in the design of equipment to be fabricated, many of which are possible because of the close liaison that exists between the design and mechanical sections and the experience of the latter in this type of work. Drawings of equipment are prepared in far less detail than would be necessary for an outside vendor. Liberal use is made of symbols and standard details. These include drawings for certain frequently used types of equipment which require only the addition of a few dimensions, etc., before release for fabrication. For example, electrically heated lead pots are commonly used for heating small streams to relatively high temperatures. Standard designs have been prepared for these as well as for helical coil gas fired heaters to handle larger quantities. Standard designs have also been prepared for various sizes of coil type coolers. Methods and equipment developed by the mechanical section have greatly facilitated and reduced the cost of winding the coils for such purposes.

Piping

Although there are instances where accurate sizing of piping is necessary, generally it is not required, and it has been advantageous to use ½-in. Sch 80 (extra heavy) seamless pipe with 3000 lb forged valves and fittings for all



Front and rear of electrical panels.

process lines wherever possible. This might, at first glance, seem extravagant, since in many cases cheaper materials or a smaller size would be adequate for the service. Piping materials, however, represent a small part of the cost of the unit and it is felt that the saving in engineering time and simplification of purchasing and stock room operations more than offset the increase in cost. The use of ½-in. as the minimum size has the additional advantage of providing greater rigidity and strength, as well as facilitating application of heaters and insulation. Where lines will carry light hydrocarbons or gases under pressure it is standard practice to seal weld, braze or silver solder all threaded joints. Wherever practical, unions are provided to permit dismantling various sections of the equipment.

Standard specifications have been set up for the various utility lines in accordance with the service. For instrument connections ¼-in. OD steel tubing with compression fittings has been found satisfactory with copper tubing and brass fittings used for instrument air lines. Standard details have been prepared for various piping arrangements which are frequently encountered.

The flowsheet provides the basis for installation of piping without necessity for detailed piping drawings. This again, is made possible by the extremely close liaison maintained between the design engineer and the construction force. The decisions as to exact location of the various lines are made on the spot. It goes without saying that experience in this type of work on the part of the construction crew is a great asset. The same mode of operation, however, has been successfully employed in erection of pilot plants at other locations with field labor. The advantage of having a man on the site who is thoroughly familiar with all aspects of the design cannot be over-emphasized.

Electrical Heaters

Because of its high surface to volume ratio, small scale equipment operated at elevated temperatures requires compensation for heat lost by radiation. In many cases this can be accomplished most satisfactorily by the use of electric resistance heaters. As a result a considerable amount of electrical work not found in the full scale is necessary in the pilot unit. To minimize the design work required in this connection, standard methods of application have been developed to meet various requirements. In addition, standard heaters of several types and capacities have been adopted; these are capable of taking full line voltage.

It is the usual practice to provide a variable transformer to control each heater. For the sake of uniformity a single size of variable transformer is used and all standard heaters are designed to match its capacity. Where the requirements exceed the capacity of a single heater in any area, two or more parallel heaters are employed with a variable transformer on one and line switches on the others.

The method just described eliminates the necessity for exact calculation of heat requirements and permits the use of a single size of conductor, circuit breaker and auto-transformer; it provides great flexibility for future modifications.

The number, type, and locations of the heaters are generally indicated on the vessel drawings or, in the case of piping, on the flowsheet. The controls are located on unit panels of the types described subsequently and drilling templates and wiring jigs are used to reduce fabrication time.

Control Board

A standard panel size has been adopted for the control and instrument boards and a design for the framing of the board has been developed which permits panels to be interchanged readily. The frame is continuous and is lo-

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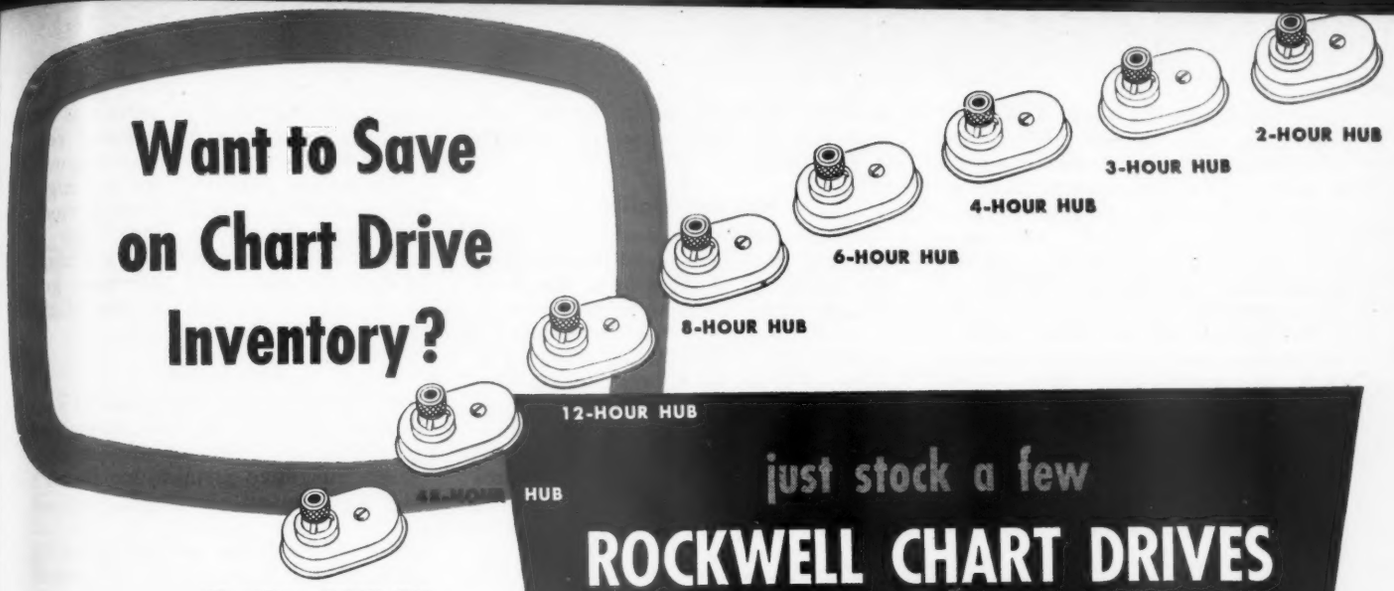

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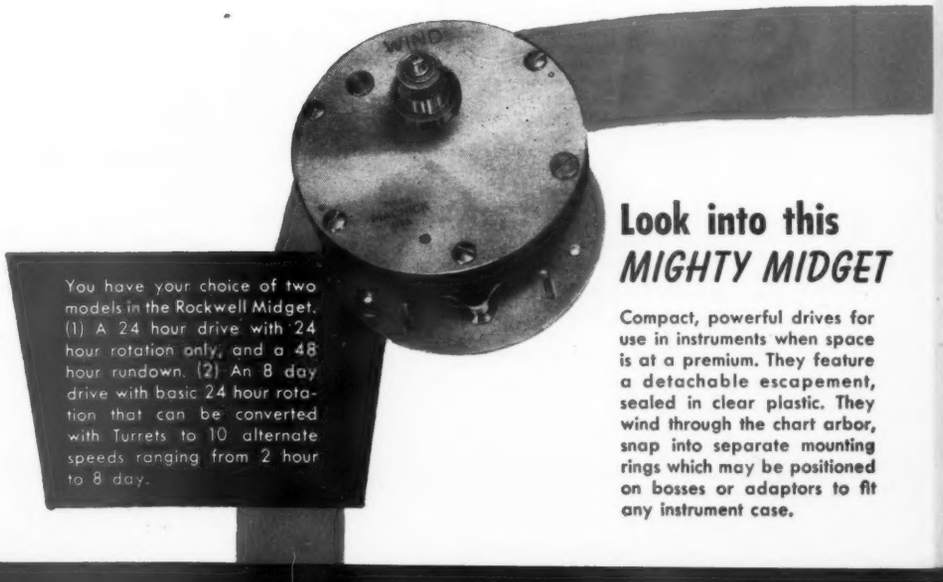

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cated just inside the limits of the pilot plant area with sufficient space behind it to permit convenient access with doors at intervals for this purpose. This arrangement provides a great deal of flexibility to meet changed requirements that may develop during the operation of the plant and aids in maintaining a neat appearance.

Standard layouts have been prepared for various combinations of commonly used instruments and other control equipment. The electrical panels carry their own terminal strips and bus bars so that they can be removed or replaced readily. The only drawing that must be made in many cases is a simple elevation sketch of the board indicating the location of the instruments and controls and the standard layout applying to each panel.

Instrumentation

As mentioned previously the control diagram and instrument designations are shown on the flowsheet. The locations of the individual instruments appear on the control board sketch. In addition an instrument list is prepared showing under the appropriate designation, the make, type, range, control characteristics, and other information pertinent to each instrument. A similar list is prepared for the various control valves. Because suitable control valves for pilot plant work were not available some years ago, a ½-in. valve was developed. This valve has proved very satisfactory in a variety of services over a considerable period of time and might be described as a single seated, modified chisel-plug valve. Four sizes of interchangeable trim give a wide range of capacity, and charts have been prepared to assist in the selection of the proper size.

Conclusion

Both design and construction of pilot plant equipment call for specialized techniques, and the development of a closely integrated group to handle such work offers many advantages. Centralization of the responsibility for all phases of the design and the use of the same individual to follow and coordinate the fabrication and erection of the equipment, eliminates the necessity for much detail. Standard details and designs can be used repeatedly with consequent saving in engineering cost. While these methods have been developed in an organization engaged in rather extensive pilot plant work, some of them, at least, should also be helpful in more limited operations.

It hardly needs to be said that the successful operation of the system described depends on the caliber of the men who make up the organization and a real desire to cooperate on the part of all concerned. With such assets it has been possible to build a large number of pilot plants with engineering costs on the order of 10 per cent to 15 per cent of the total.

Acknowledgment

The author wishes to acknowledge the many contributions of his associates and express his gratitude to the M. W. Kellogg Company for permission to publish the information contained herein. * *

Shell Chemical Builds Sulfur Recovery Plant

Shell Chemical Corporation has announced it will add to its Houston, Texas, operations a unit for recovering sulfur from waste refinery gases. Output of the new unit will be sold for conversion to sulfuric acid. Sulfuric acid, or oil of vitriol, is so fundamental a chemical with so many varied commercal uses (chemicals, oil, steel, paper, fertilizers, paints, to cite a few), that its total consumption provides a pertinent index of the industrial activity of any nation. At this time sulfur consumption in the U. S. is 500,000 tons more than the domestic production.

The new sulfur recovery unit, certified by the government as a necessary defense project, will be constructed by the Ralph M. Parsons Company of Los Angeles. Operation is expected by mid-1952. In the recovery process, waste refinery gases, containing hydrogen sulfide, carbon dioxide, and a small percentage of light hydrocarbons, will be burned and catalytically converted to sulfur at an annual rate in excess of 13,000 tons.

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Q Show how to compute the optimum economic thickness of insulation for an assumed set of conditions in refinery operation, and assuming the cost of heat production (price per million Btu) and prices per unit of insulation of various thicknesses.—D. L. E.

A Both these questions will be answered together, as only one problem is inherently involved.

In the insulation of any pipe or piece of equipment, the problem is finally an economic one. The point of least overall cost of operation is the desired operating level. The general procedure, knowing or assuming reasonable values for the quantities mentioned in the questions, is to assume various thicknesses of insulation and calculate the operating cost for each insulation. The problem can be extended to include several types of insulation, with the same procedure being followed for each type. The procedure can best be explained by example. Example 1, below, is a typical example of this type of problem.

Example 1: Calculate the most economical thickness of magnesia-asbestos insulation to apply to a high pressure steam pipe (1-in. outside diameter = 1.315 in.). The temperature of the pipe (skin) is 370 F, and that of the outside air is 80 F. Steam costs $0.30 per million Btu, and lagging costs per foot of pipe are as follows:

$0.30 for ½ in. thick
0.64 for 1 in. thick
1.47 for 2 in. thick
2.52 for 3 in. thick

The annual cost charges for this insulation are 20 per cent of the cost price/year. For magnesia-asbestos insulation, k = 0.042 Btu-ft/(hr)(sq ft)(°F). It is assumed that there is a continuous supply of steam throughout the year. Calculations will be made on the cost of operation of 1 ft of pipe per year.

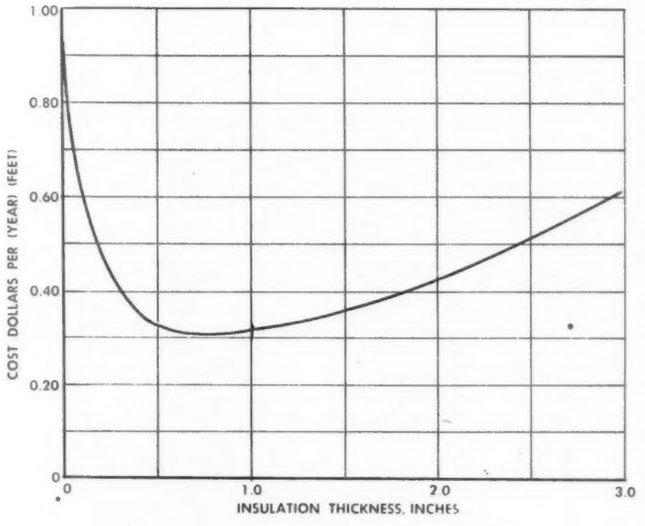


FIG. 1. Economic Insulation Thickness

Solution: It is necessary to assume various thicknesses of insulation, calculate the operating cost for each thickness, and compare the costs of operation. The minimum cost is, of course, the economic optimum thickness.

1. *Calculation of Heat Transfer Areas.*

Assume insulation thickness is 3 in. (Detailed calculations will be made on this thickness)

$$L = 3/12 = 0.25 \text{ ft}$$

$$\text{O.D. area} = \frac{\pi(1.315+2L)(1)}{12} = \frac{\pi(1.315+6)(1)}{12} = 1.914 \text{ ft}^2$$

$$\text{I.D. area} = \frac{\pi(1.315)(1)}{12} = 0.344 \text{ ft}^2 \text{ (constant for all thicknesses)}$$

$$\text{Log mean area} = \frac{1.914-0.344}{\ln \frac{1.914}{0.344}} = 0.914 \text{ ft}^2$$

2. *Heat Transferred per Year.*

q = UA Δt; Δt = 370—80 = 290 F. (constant for all thicknesses).

Insul. thickness in.	L ft	A_{id} ft²	A_{od} ft²	A_{lm} ft²	$\frac{L}{kA_{lm}}$	$\frac{1}{hA_{od}}$	UA_s
0	0	—	0.344	—			1.220
½	0.042	0.344	0.606	0.463	2.15	0.701	0.351
1	0.083	0.344	0.866	0.565	3.51	0.523	0.248
2	0.167	0.344	1.392	0.749	5.30	0.332	0.178
3	0.250	0.344	1.914	0.914	6.51	0.242	0.1438

Insul. thickness, in.	Δt °F	BTU/q(yr)(ft)	Insul. cost $/yr-ft	Steam cost $/yr-ft	Total cost $/yr-ft
0	290	3.09×10^6	—	0.927	0.927
½	290	8.92×10^5	0.060	0.267	0.327
1	290	6.31×10^5	0.128	0.189	0.317
2	290	4.51×10^5	0.294	0.135	0.429
3	290	3.76×10^5	0.504	0.112	0.616

$$UA = \frac{1}{\frac{L}{KA_{lm}} + \frac{1}{hA_{od}}} =$$

$$\frac{1}{\frac{0.25}{(0.042)\,(0.914)} + \frac{1}{h\,(1.914)}}$$

$$UA = \frac{1}{6.51 + \frac{0.522}{h}}$$

"h" is the surface heat transfer coefficient, and is equal to $h_c + h_r$. As may be seen from Perry[1], the value for this coefficient depends on the temperature difference from the surface of the insulation to the air.

Assume Δt (insulation surface to air) = 10 F

h (Perry, pg. 475) = 2.16

$$UA = \frac{1}{6.51 + 0.24} =$$

0.1481 Btu/(hr) (°F) (ft of pipe)

$q = 0.1481 \times 290 = 42.9$ Btu/(hr) (ft of pipe)

$q = 42.9 \times 24 \times 365 = 376{,}000$ Btu/(yr) (ft of pipe)

To check assumed Δt,

$q = hA\Delta t$, where Δt is from insulation surface to air.

$q = 2.16 \times 1.914 \times 10 = 41.4$ Btu/(hr) (ft of pipe)

Therefore, value for *h* is close enough.

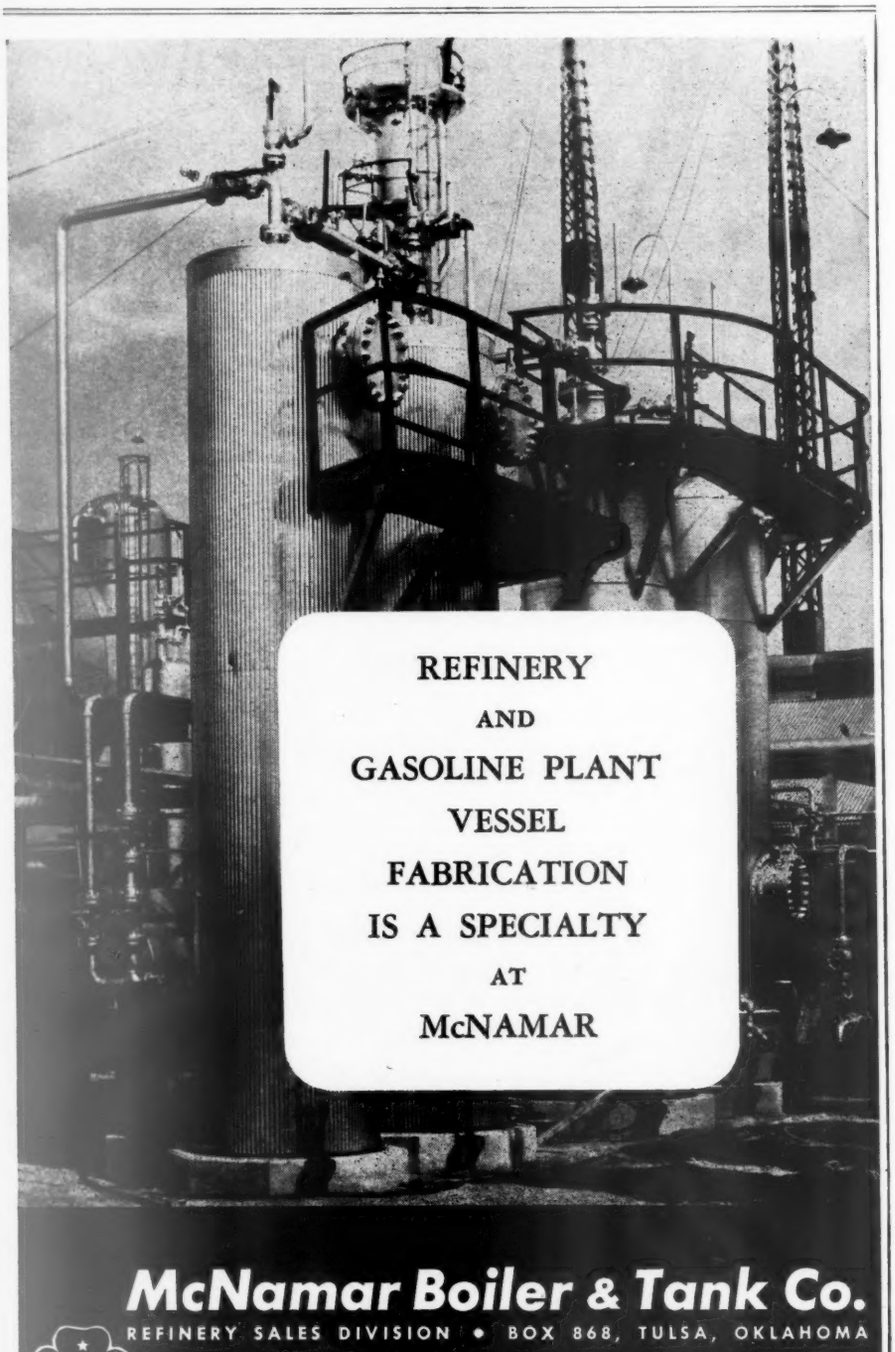
3. *Cost of Operation per Year.*
Steam cost = 376,000 × \$0.30/10^6 = \$0.113/(yr) (ft)
Insulation cost = \$2.52 × 0.20 = \$0.504/(yr) (ft)
Total cost = 0.113 + 0.504 = \$0.617.

4. *Tabulation of Calculations* (Calculations for other thicknesses of insulation were made in similar manner).

The results of the calculations, taken from the above table, are shown plotted in Fig. 1, "Economic Insulation Thickness." As may be seen from this plot, the economic thickness is between ½ and 1 in. One inch of insulation would be installed under the above conditions.

G. L. Farrar

[1]Perry, Chemical Engineer's Handbook, 3rd Edition, McGraw-Hill Book Co., pg. 475.



Standard Indiana Ships Benzene From New Unit

Standard Oil Company (Indiana) has begun commercial shipment of benzene produced from petroleum in the new benzene plant at its Whiting, Indiana, refinery. Dr. M. G. Paulus, vice president in charge of manufacturing, who made the announcement, also revealed plans are already being made to expand the new plant. The present Whiting plant will produce about 11,000,000 gal of benzene per year. Expansion, scheduled for completion in the second half of 1952, will increase the capacity to 16,000,000 gal per year.

Benzene is in strong demand as a result of the defense program, Paulus said. It is used extensively by the synthetic rubber, chemical, and other industries. Until fairly recently, he said, benzene was almost exclusively a by-product of coke production. Output from this source, however, has been insufficient to satisfy the growing demand, and a nationwide shortage of the chemical has developed. In view of this shortage, Standard authorized the benzene manufacturing project last February. Most of Standard's benzene production will be sold to the chemical industry under long-term contracts.

Last year a Standard subsidiary, Pan American Petroleum and Transport Company, began commercial shipments of benzene produced from petroleum at the Texas City, Texas, refinery of Pan American Refining Corporation. Indoil Chemical Company, another Standard subsidiary, has also been producing benzene on a small scale for the last year.

Standard Oil Company (Indiana) entered the petroleum chemicals field a number of years ago, and has since been expanding its activities in the field.

Practical Research Improves Refining Mechanics

Whether pump seals, corrosion of metals, or designing pressure vessels, experimental methods pay dividends.

W. T. ZIEGENHAIN

APPLICATION of new developments in the mechanical field of petroleum refining in an experimental way to determine their efficacy, and to discover how these new ideas should be revised and improved, was one of the keynotes of the meeting of oil industry mechanical engineers at the Petroleum Mechanical Engineer's Conference at Tulsa, Oklahoma, Sept. 24-26. Progress in the solution of the refining industry's innumerable mechanical problems was reported in a group of 25 papers on a wide variety of subjects ranging from the latest in the art of welding metals to the techniques of refinery cost estimation. A total of 10 sessions were held, attended by mechanical engineers from all over the refining industry, while at the same time other divisions of the oil and gas industries were meeting for identical purposes.

Reflecting a most timely approach to the refinery centrifugal pumping problem, L. P. Ellis, Jr., and C. L. Fussell of the Esso Standard Oil Company, in Baton Rouge, Louisiana, explained how that company now effectively retains vapor-tight assemblies in its revised centrifugal pumps. Their findings were based upon that plant's having installed approximately 350 seals of several types since 1938. These experiences were based upon a full range of light oil service from propane to crude oil.

It so happened that many of these units had operated as replacement units for pumps designed originally to be serviced with soft packing. In the revision the new gland plates were generally patterned in shape to follow the contour of the packing glands of the original pump.

To emphasize most effectively the importance of retaining a tight seal at this point, the authors inferred that the entire organization is mindful of the fire that occurred at their plant early in 1950 and before these pumps were so equipped. "Fortunately" they indicated "no personnel were injured". It was explained that the unit so involved was a 9-stage, 600 gpm centrifugal pump, having a suction pressure of 300 and discharging at 1200 psig.

The original soft packing had been replaced with a mechanical seal. In this instance the throat bushing, which is often found in such installations, had been omitted. With this experience as a background, this assembly was redesigned to include a sealed gland with a raised face, a narrow gasket and 5 high-strength bolts meeting the ASTM specification A-193, Grade B-7.

Backed by this actual experience, it appeared most practicable to revise the original installation whereby the new one would have 3 bolts attaching the sealed gland to the pump case. The initial design pump practice called for high-strength bolting, raised face gasket services, throat bushings and sealed gland plates. The size of the respective bolts met those outlined in the API-ASME and ASME codes for Unfired Pressure Vessels. Three bolts were used instead of two in all instances that permitted such deviation.

The maximum probable estimated bolt loads were determined. The second formula designates the initial bolt load necessary to seat the gasket under atmospheric conditions and in the absence of internal pressure. Obviously the larger of the two values determined from these two formulae established the specifications. In most pump installations the ASME code governed.

The decision to use high-strength bolting materials necessitated the determination of proper thread engagement in all instances.

In actual practice, it must be recognized that cast iron, brass and other relatively low-strength materials had to be evaluated. In such instances it was found that the commonly used depth of one bolt diameter for tapped holes made the pump threads considerably weaker than the bolting. In order to insure that the pump threads on the main body would at least be as strong as those on the bolt, the required depth of thread needed had to be determined by equating the tensile strength of the bolt as compared with the shear strength of the threads of the weaker member. These depths were converted to nominal bolt diameters for general use in the shop. The resulting data were applied in all instances except where excessive stresses were likely to occur. Such instances usually involved the through-member of an eye-bolt assembly shearing the pump case.

It was impressively stated that at the time the redesigned problem was begun, many thin seal gland plates were known to have bent sufficiently to cause gasket leakage or carbon insert failure and that some practical and quick means had to be found to establish gland seal thickness of sufficient rigidity to prevent leakage or failure. While the method chosen by the engineers at this refinery might be considered "empirical", it has proved itself to be practicable to date.

The seal gland thickness was fixed by the specified dimensions of a hub standard slip-on flange having the same series rating as that applied to the pump discharge flange and having a bolt circle diameter nearest that of the seal gland.

As a result of this work and when the company engineers now call for bids on new pumps in similar service, such provisions are given recognition.

To date 111 pumps have been so redesigned for use in this plant. It is interesting to note that approximately 85 per cent of the installations checked have required more bolting strength and about 25 per cent have required thicker seal glands.

The authors offered this plea to the mechanics who regularly assemble and disassemble such installations "Do not weaken the installation by the substitution of different materials for different sized parts . . . . Experience indicates that the mechanical forces recognize the importance of proper seal installations and are willing to call in the design engineers before making any changes."

Pressure Vessels

A detailed means for calculating the respective stresses set up in any pressure vessel having a conical head was given in a paper prepared by G. W. Watts, director of engineering for the Standard Oil Company of Indiana and H. A. Lang of the engineering research department of that company. Such data obviously have broad application. The accurate bending theory of shells can be used to evaluate the local bending stresses present in the neighborhood of the juncture between the conical head and the cylindrical body. Tables were presented to show the magnitudes of the shear stress, the circumferential stress and the axial stress at the respective junctions and as multiples of $pd/2t$ where p is the internal pressure (psi), d is the diameter of the circular juncture in inches and t is the thickness of the cylinder plate as expressed in inches.

In addition, results were enumerated regarding the magnitude and location of 3 types of maximum stresses within a cylinder. Curves were shown to depict the maximum stresses for values of the cone apex angle, the ratio of the conical head thickness to the cylinder thickness and the ratio of cylinder diameter to the cylinder thickness.

Obviously such data are found to be unusually practicable in developing the operation of a modern plant.

Pressure Catalysis

Because of the high regard felt among petroleum plant men for the practicable type of research accomplished under the chemical and metallurgical engineering department of the University of Michigan, special cognizance was given the stated plans of C. M. Sliepcevich and G. G. Brown.

Under their supervision the results were enumerated following experiences gained over the past three years while operating a small scale plant for the study of catalytic reactions at high temperatures and pressures. This operation has been used under experimental pressures as high as 10,000 psig and temperatures as high as 1200 F.

As a result of the investigations to date, present plans call for the department's perusal of experiences to be gained from the operation of a unit capable of withstanding an internal force of 20,000 psi pressure and 1000 F.

It was pointed out that to the inexperienced, the word "caution" should be a byword. High pressures and temperatures were not to be feared, but were to be respected.

Plant Corrosion

Reflecting a thorough and impartial analyses of the refiner's corrosion problems, John F. Mason, Jr., of the International Nickel Company, emphasized that only through experience and research can the solution of the corrosion problems in the modern refinery be alleviated. He enumerated by name the materials used and general service conditions existing under each of 15 practicable plant problems. To augment the particular findings, conclusions were also based upon data derived from the observance of spool-type specimen holders, which assembly had been suspended in the operating equipment and under actual service conditions.

In view of these findings the author said, "The trend is toward the use of more highly alloyed materials, such as monel and nickel together with copper base alloys like 70-30 cupro-nickel, Admiralty metal, and Muntz metal".

No simple statement can therefore be used and any particular corrosion plant problem can be solved only as a result of the operator and the supplier of the equipment offering the most cooperative engineering views.

Cost Estimates

In keeping with the rapid rate with which changes are being made in refinery processing, backed with the high degree of technological reasoning needed to judge new developments, Robert P. Wilson of the Mid-Continent Petroleum Corporation summarized his suggestions on the subject by saying "First, find out what is to be done—obtain flow diagrams, plot plans, utility surveys, and specifications of materials to be employed. Second, break the job down into comprehensible items. Third, estimate the costs of individual items and summarize costs. Fourth, prepare a revised estimate, if consideration is long delayed. Finally, to improve technique, compare final job costs with originally estimated costs."

Coal Hydrogenation

Competition promotes technological changes and it is only logical that the oil industry keep cognizant of practical research results as they are made available by the Bureau of Mines coal-hydrogenation demonstration plant at Louisiana, Missouri.

It is apparent that high pressures must be recognized as essential to the desired synthesis of suitable automobile fuels from coal. In the statement of C. E. Balcerzak and J. R. Skillern of the synthetic fuels demonstration plant at Louisiana, Missouri, it becomes apparent that unusually high pressures must be resorted to. Items entering the construction of the reaction zone must operate in accordance with design principles for 20,000 lb service.

Investigations were conducted on several types of special steel tubes. Suitable product results were effected from using AISI-316 stainless steel and which had a performance record in excess of 100 days. To date the investigations have been applied to service conditions requiring AISI-316 stainless steel tubes for 20,000 lb service pressure and with an over-range protection to 30,000 psi. Needless to say with emphasis, other types of tubes have been under investigation.

Because of the high pressures involved in the conversion and because of the limited availability of suitable materials for the construction of equipment needed to effect the synthesizing of large volumes of liquid fuels from coal, the practicability of replacing petroleum by coal as a source of economical automotive energy appears to be quite distant.

* * *

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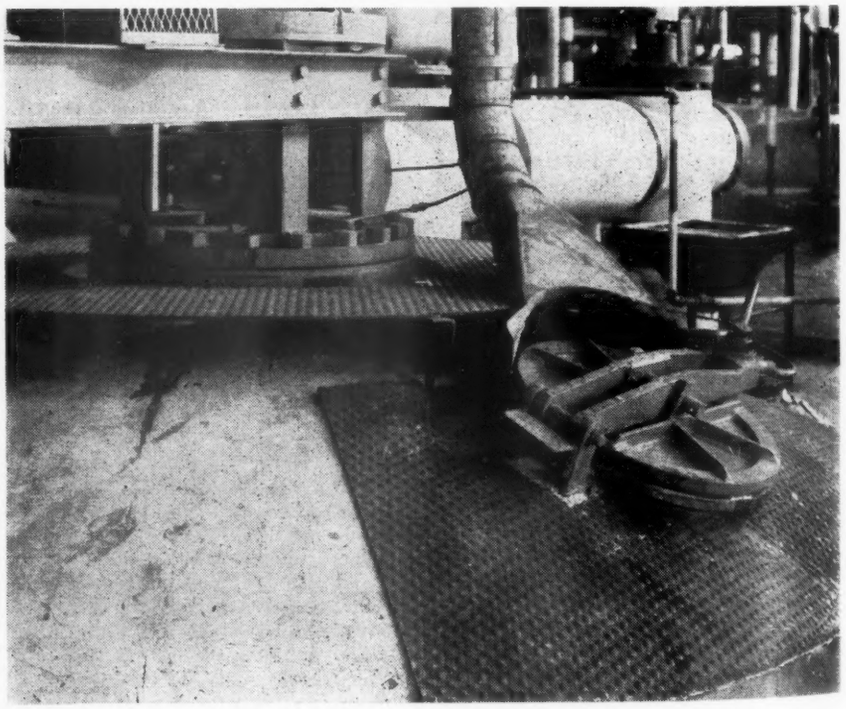
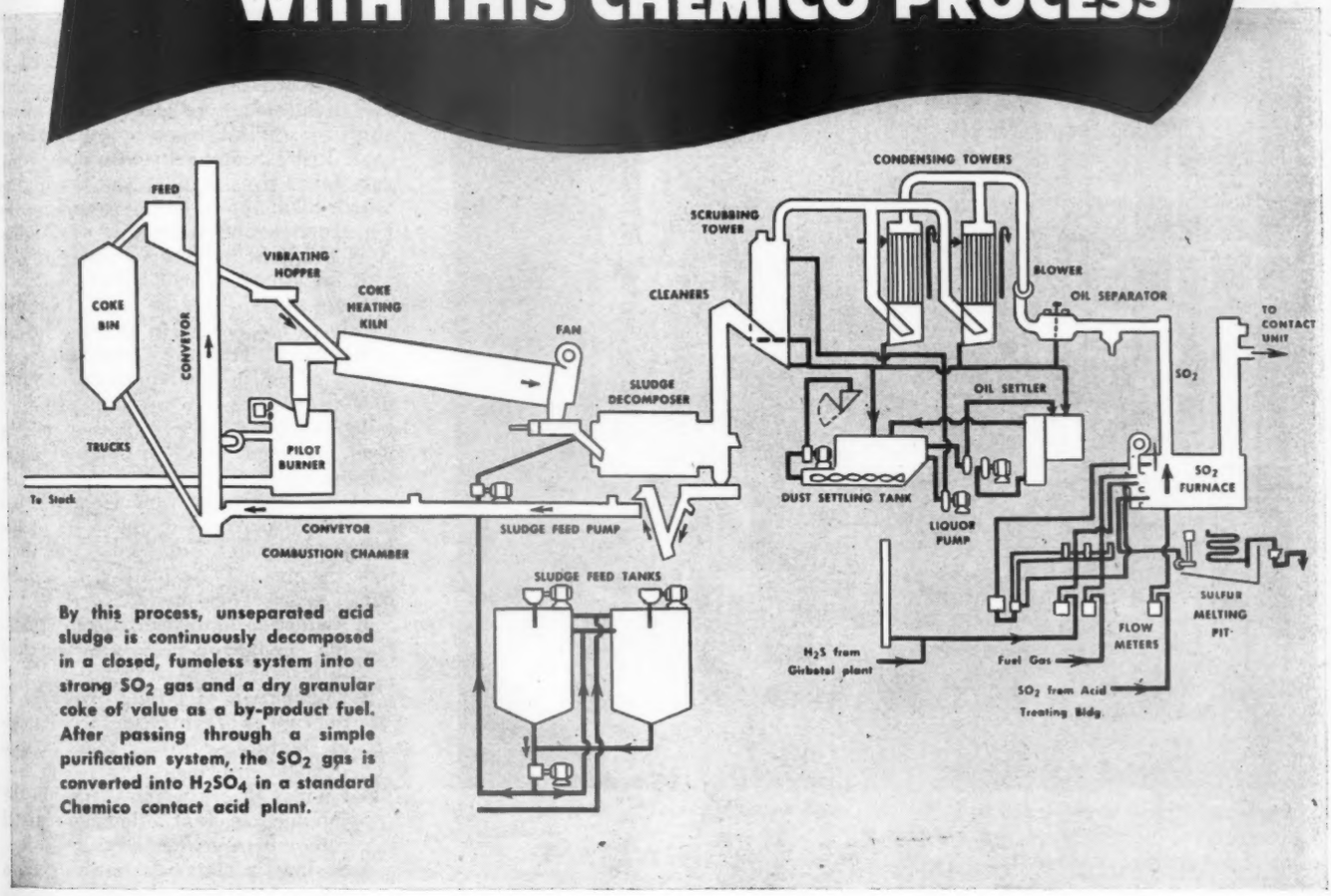


Skid-proof metal plates protect insulation around the center and hatch of a reaction kettle at a Pennsylvania chemical plant. Additional expense of metal plates is small compared to savings obtained by reduced maintenance.

Make Sulfuric Acid from Refinery Sludge

WITH THIS CHEMICO PROCESS



By this process, unseparated acid sludge is continuously decomposed in a closed, fumeless system into a strong SO_2 gas and a dry granular coke of value as a by-product fuel. After passing through a simple purification system, the SO_2 gas is converted into H_2SO_4 in a standard Chemico contact acid plant.

With the increasing shortage of raw sulfur, industry is turning to other materials which can be used for making much-needed sulfuric acid. An important source—waste oil refinery sludge—can be converted into clean sulfuric acid of any desired strength by the Chemico process shown in the flow diagram.

This proved and practical process offers three important advantages. (1) The purified SO_2 gas provides a product acid that is free of carbon contamination. (2) The resulting H_2SO_4 may be 98% or any higher strength regardless of the initial strength of the sludge. (3) Sludges that cannot be processed by other methods may be satisfactorily used in this system.

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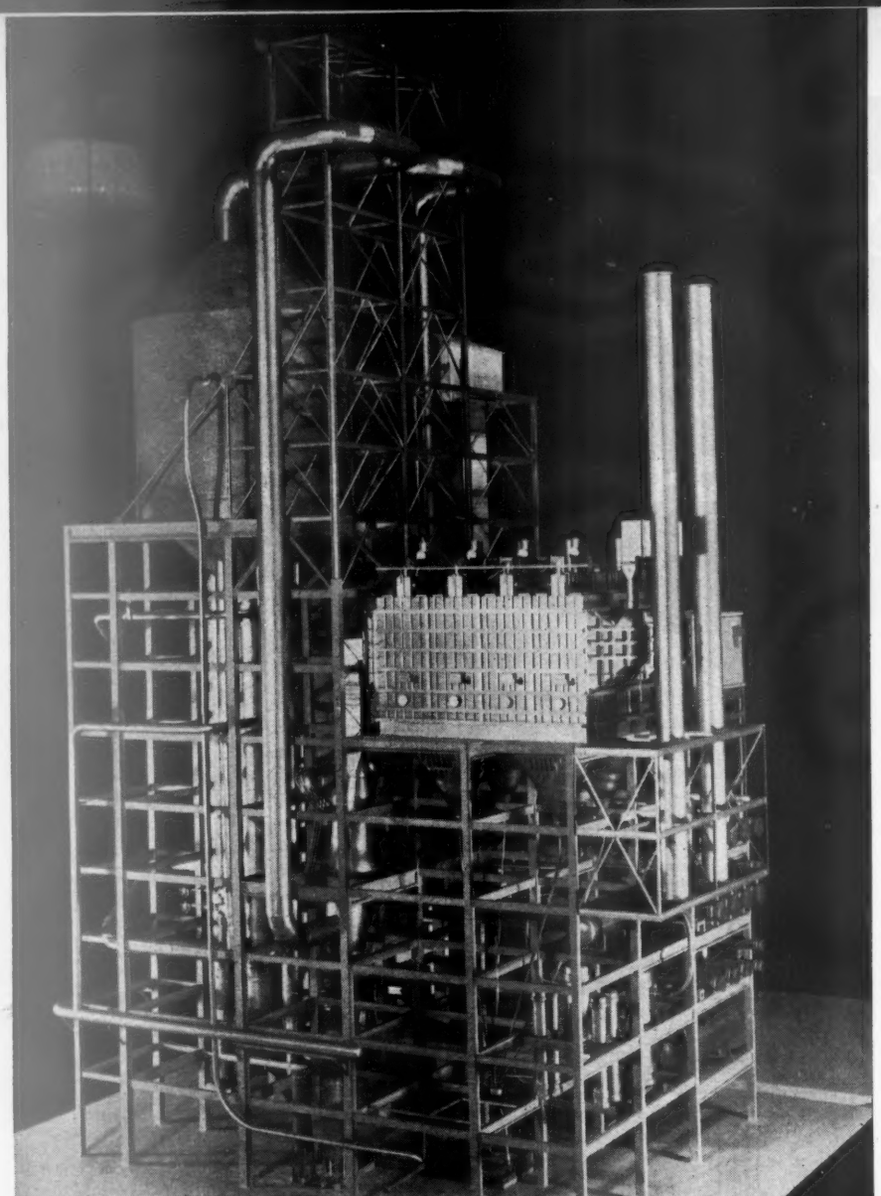

P 731.

Pilot plant model of a Fluid cat cracker displayed at the M. W. Kellogg Company offices.

The Use of Scale Models in the Petroleum Industry

MARSHALL SITTIG*

PLANNING a new catalytic reforming unit? Wondering how to locate that new desalter? Build a model!

Everybody's doing it. Monsanto, DuPont, Dewey and Almy, and the Atomic Energy Commission have found industrial models to be useful tools. Shell Oil Company has built such models. The various refinery construction organizations have long featured models of proposed plant installations in their advertisements in the trade journals—you've seen them on the pages of this and other magazines in advertisements of M. W. Kellogg Company, Foster-Wheeler, Proportioneers, Inc., Blaw-Knox, and others. Unlike inventors' models, these models contain no moving parts as a rule. They are simply designed to permit easy visualization in three dimensions of equipment that might otherwise be depicted in complicated manner in two dimensions on a series of blueprints. As one individual put it, "It translates the Greek of blueprints into plain English."

The value of models was proved in World War II when rubber scale models of beachheads were placed on invasion ships for use in briefing before the landings. Just as familiarity with enemy terrain saved lives then, so can familiarity with a plant layout now save time in the construction and startup of new units. A model built today may put your new unit on stream sooner tomorrow.

Scale models may be used "from the cradle to the grave" in refinery design departments. They are useful in presentation of the original brainstorm for a new processing scheme and, after detailed mathematical design, they may be used (in some cases) in place of working drawings.

Model costs may vary from 0.1 per cent to 1.0 per cent of the costs of the commercial plant. But, models pay their way. Savings may be realized in a number of forms. These include:

1. Reduction in drafting time by making changes in models rather than in several sets of drawings.
2. Elimination of piping drawings in the case of organizations using models to replace rather than to supplement drawings.
3. Savings of craftsmen's time on the job due to ease of following a model rather than a blueprint.
4. Savings in materials resulting from fewer changes on the actual job.
5. Final evolution of a safer, more convenient, and generally more satisfactory plant layout resulting in decreased operating expenses.

Let us outline the many ways in which scale models may be used.

In Advertising and Sales. The use of models may be applied to presentation of a new plant layout in palatable form in magazine advertising for prospective buyers. It may take form in the presentation of a proposed piece of equipment to a non-technically trained board of directors for financial approval. Architects have long used models in the presentation of designs to prospective clients. Alert chemical design engineers are now following their lead.

An interesting use of models was that made recently in the presentation of the design of the new United Nations skyscraper to the delegates—who speak 58 different languages—in the form of a model that speaks the universal language. Presentation of ideas to native

*Chemical engineer, Detroit, Michigan.

EXCLUSIVE

B of M Report Describes Australian Shale

A U. S. Bureau of Mines report describes in detail how Australia has been producing motor gasoline and allied products on a commercial scale from native oil shale. The Glen Davis plant, scene of Australia's shale oil production, began operations in 1940. The shale there is in three seams with a maximum thickness of 7 ft, the report states. At one face a single 2-ft seam is exposed. Production averages 8½ tons a day per face worker, or 3 tons per employee in the mine, which is operated like a mechanized coal mine.

A Fisher assay value of about 140 U. S. gallons a short ton has been given the main seam, probably making it the richest oil shale seam being mined in the world.

The B of M report states the daily output of 400 tons of shale could be increased if a larger mining force could be obtained. The retorts and refinery could handle almost twice the shale processed in 1947.

The principal product marketed at Glen Davis is motor gasoline, which has a motor method octane rating of 70 to 71 with 1.25 milliliters of tetraethyl lead a gallon. Other products in small quantities include liquefied petroleum gases, cresols, and cracking-still coke.

Australia apparently began commercial oil production in 1865, according to the report. It began with kerosine, candle wax, and oil for improving the illuminating quality of manufactured gas.

officials by the foreign departments of oil companies should find models equally useful.

You may have seen scale model kitchens at your electric appliance dealer's recently. Such models permit housewives to visualize cabinet, stove, and refrigerator locations in their kitchens. By the same token, you may help a client to visualize the location of a new crude column in an expanded refinery.

In Design. The use of scale models will permit better efficiency of space utilization. It will make obvious such things as unused overhead warehouse space, indicating the use of lift trucks and tiering of packaged products, for example. This technique will avoid what the chemist calls "steric hindrance" and will prevent a pipe line on one drawing from intersecting with an I-beam on another drawing when the final plant is erected. Even though no actual interference occurs, awkward setups may be avoided, which could cost many dollars over the years in inconvenient operation.

A design application where models have long been used is in the design of automobile bodies. Here, clay models are reviewed by production executives as a necessary prelude to the construction of pilot models. Another use of scale models has been in shipbuilding where the model basin is an integral part of the equipment of any group of naval architects.

In Construction. The Dewey and Almy Chemical Company has carried the use of models to an extreme as reported by W. Allphin.[1] This organization allots one per cent of the total project cost to modelmaking. Based on production requirements, models of the individual pieces of equipment—autoclaves, columns, heat exchangers, etc.—are made. The approximate external structure is then built up. Third, the equipment is located—and fourth, the piping is installed. According to Allphin, some Dewey and Almy installations have been made without any piping drawings. The model was taken to the job and the pipefitters and other craftsmen worked directly from it.

In Operating Work. The model may be used by industrial engineers to trace the movement of workmen and to plan for most efficient utilization of the minimum operating crew. It may be used to train student operators for new plants.

Safety considerations may better be built into the operating plant through prior study of the model by safety engineers. These engineers may instantly spot an unsafe condition on the model that they would be unable to visualize in laboring through a roll of blueprints.

Transparent plastic models of Liberty and Victory ships were employed in World War II to permit foremen to determine, in advance, the best sequence of operations to be followed in assembly of prefabricated sections. Similarly, studies might be made in the petroleum industry of intricate problems on turnarounds.

Some one of the above applications of industrial model making has probably come close to your interests. The question of how to make such a model now comes up. Actually, we are faced with questions of "Who will do it?" and "How will they do it?"

There are now a number of organizations specializing in the construction of industrial models. Thus, an organization that cannot afford to employ one or more full-time men, or an organization that would like to explore the possibilities of the field before committing itself to the creation of a model-making department, may employ the services of one of these specialists.

One very interesting service is that offered by a firm that supplies a complete line of machine tools, shapers, grinders, lathes of all well-known makes, all in a ¼ in. equals 1 foot scale. These models would be directly applicable to the detailed planning of refinery shop facilities. These pieces offer a modern, improved version of the old cardboard template method.

Refinery models may be made of wood, plastics, or metal. One very useful combination consists of wooden replicas of equipment with transparent sheet plastic walls and floors. Exact duplication of exterior surfaces is usually unimportant and plastic walls permit easy vision into the plant interior. U. S. patent 2,523,508 by L. A. Ledgett covers one particular type of construction of 3-dimensional models using perforated floors and equipment joined by pins which pass through these perforations. Models of chemical manufacturing facilities are illustrated in this patent.

Even cardboard may be used in model making, however. It results in considerable savings in weight and in model cost over other materials of construction when its use is permissible. Full-scale models of gas-turbine engines and of oil refinery pumps have been constructed of cardboard for display purposes.

Rubber tubing or flexible plastic tubing may be used in the initial steps of construction of the model—to give a schematic indication of process piping. After the various vessels have been connected in this temporary manner and the flow scheme has been found satisfactory, final piping locations may be made using wooden dowels, plastic tubing or rods, or copper or aluminum tubing.

Cellulose acetate or methyl methacrylate plastics may be used for model making. Such plastics are commonly available in sheets in thicknesses from 1/16 in. to 2½ in. and in rod form from ⅛ to 1 in. in diameter as well as in tubing of various sizes. The various plastics manufacturers have manuals available on the handling of these materials—giving recommendations as to the proper techniques for cementing these materials, machining them, etc.

The use of plastics may be carried further than the walls and floors. Plastics may be used to construct kettles and bubble towers — so that bubble plates may be seen inside the towers—and agitators and heat-transfer coils may be seen inside the kettles. There is the question of how much detail is justified—but each piece of equipment should be detailed enough to be instantly recognizable so that discussion of a model by various individuals may be unhampered by problems of identification.

Pipe lines may be identified as to exact pipe sizes by tabs bearing numbers indicating the pipe sizes in inches.

Models may be made in a variety of scales. Dewey and Almy have used one inch to the foot in their models. A more common size is ¼ in. to the foot. A scale of one inch to the foot creates a model whose overall size is such that it must often be split to permit it to be moved through an ordinary door.

Stereoscopic photographs may be made of models for record purposes.

Finally, television offers a fascinating medium for the presentation of ideas with models—perhaps to show the public your expanded bulk plant facilities to permit serving them better, done with the aid of a model. * * *

[1] Allphin, W., Chem. Eng. News *21*, No. 8. 556-8 (April 25, 1943).

Waring Discloses Europe's Methods of Solving Its Sulfur Shortage Problem

The sulfur shortage is of comparatively recent origin in the U. S. Dr. C. Waring, vice president for research of the Davison Chemical Company told members of the Pennsylvania chapter of the American Institute of Chemists at a dinner recently. He added, however, that shortages have existed in Europe for some time, causing those countries to develop greater means of overcoming it. He cited France particularly as having shown ingenuity in this direction, stimulated by the blockade during the last war when pyrites, a source of sulfur, could not be imported.

Processes that have contributed the most either to the output of sulfuric acid or the saving of the acid, Dr. Waring said, were the production of the acid using gypsum as a raw material and producing cement clinker as a coproduct; use of a mixture of approximately 50 per cent sulfuric acid and 50 per cent nitric acid for acidulation of phosphate rock to produce nitraphosphates; use of gypsum with ammonia and carbon dioxide to produce ammonium sulfate without the use of sulfuric acid. Waring recently returned from Europe.

World Commerce Will Represent Houdry Abroad

Houdry Process Corporation has completed arrangements with World Commerce Corporation under which World Commerce will represent Houdry in negotiating foreign process licenses throughout the world.

It is expected that the new arrangement will materially expedite dissemination and use of scientific advances made by Houdry for the production by catalytic processes of high-grade petroleum products, high octane gasoline, petro-chemicals and synthetic rubber materials.

In addition to licensing of Houdry processes covered by Houdry patents abroad, arrangements between the two companies will make available engineering and design services in the overall field of petroleum refining, and the facilities of the Houdry laboratories at Linwood, Pennsylvania. In addition, Houdry will make available consulting engineering, construction, and technical services.

LGP Station Proposed

Houston, Texas may have the first filling station for vehicles burning propane and butane gas. If the proposed station is built, it will be the first of its kind in Texas. Increasing numbers of trucks, buses, cars, and tractors are using liquefied petroleum gas instead of gasoline.

New Type Flare Burner

A new field flare burner designed by John Zink engineers features smokeless burning of large volumes of disposal gases along with low steam consumption and high resistance to heat damage. The new flare is for use in refineries, gasoline plants, chemical plants, sewage disposal plants, and other facilities where excessive volumes of gas must be burned as a means of disposal. The company announced that the burner is made of heat resistant alloys and employs a new method for cooling of the burner parts in combination with completely stable piloting in winds up to 80 miles per hour.

Dedicatory Program Held For Snyder Gas Plant

Dedication of the recently completed Snyder, Texas, gasoline plant to the causes of natural gas conservation was observed recently. It is being operated by Sunray Oil Company for a group of company owners. Construction of the $8,000,000 plant was begun in July 1950 and went on stream for the production of gasolines and liquefied petroleum gases (LPG) products in June of this year well ahead of schedule. The plant which extracts casinghead gasoline and other by-products from the natural gas of a large portion of the Kelley-Snyder canyon reef field in Scurry County, serves some 35,000 productive acres and approximately 850 producing wells. The initial design processing capacity of 70,000,000 cu ft of gas per day anticipates a recovery of more than 547,000 gal of liquid products daily.

Deep Rock To Expand Lube Oil Facilities

The Refinery Engineering Company of Tulsa, Oklahoma, has been awarded a contract by Deep Rock Oil Corporation for site preparation and installation of various auxiliary equipment in connection with their lube oil expansion program at Cushing, Oklahoma.

The contract includes the installation of a 3500 gal per minute cooling tower with pumps and piping, revamping of electrical facilities, the addition of numerous product lines, and the extension of the present fire protection system.

Engineering is to proceed immediately with field construction to follow shortly thereafter. This is part of an extensive modernization plan upon which Deep Rock has been engaged for some time and the new work at Cushing will continue into 1952.

Pan-Am Moves Offices

Pan-Am Southern Corporation has moved into Lee Circle Building, New Orleans, Louisiana. The new building is the completely remodeled Bienville Hotel. The company leased the building for a 30-year period. It will occupy the fifth, sixth, and seventh floors of the building, and part of the fourth floor.

Synthetic Plants Want Government Price

Proposed synthetic fuel plants in Illinois and Colorado are still under discussion. In Illinois, the project would be in the southern part of the state where 38,000 acres of coal lands are under option to Colchem Corporation, which proposes to build a plant to turn the coal into petrochemicals and synthetic oil. The company wants the government to guarantee a minimum price for its products. The process to be used at this plant would be like that the government uses in its $25,000,000 demonstration plant at Louisiana. Here gasoline is produced by adding hydrogen to coal and refining the product through many steps.

Tracy Named to NPA Chemical Division

Osgood V. Tracy has been named deputy director of The National Production Authority, U. S. Department of Commerce chemical division. Tracy is on leave as general manager of the Chemical Products Department of Esso Standard Oil Company. For more than 20 years he has been engaged in the commercial development and manufacture of chemicals from petroleum. Formerly operations head of Standard Oil Development Company, the central technical organization of Standard Oil Company (New Jersey) affiliates, and manufacturing coordinator of chemical products for Esso Standard, Tracy is also a director of Enjay Company.

With NPA Tracy will work with Kenneth H. Klipstein, director of the chemical division, in aiding the chemical industry to meet necessary production goals and in distributing scarce chemicals to defense and essential civilian uses.

Shell Research Chemists Receive Assignments

In order to obtain broader experience with refinery operating problems and to apply their own specialized abilities to these problems, three Shell Development research chemists left for temporary assignments at Shell Oil refineries.

J. H. Raley, whose field is reaction kinetics, has been assigned to the Houston refinery for a two-year period. J. W. Otvos, who has been using isotopes to investigate reaction mechanisms, and G. E. A. Wyld, analytical chemist, will go to the Wood River refinery. Otvos' assignment is for two years; Wyld's is for approximately a year, in an exchange with K. Kressler of the control laboratory staff at Wood River, who will join the Shell Development analytical staff.

NGAA Proceedings Out

The California Natural Gasoline Association, Los Angeles, has published proceedings of the twenty-fifth annual fall meeting. The meeting was held November 9-10, 1950 in the Ambassador Hotel, Los Angeles, California.

Australia Will Get Its Largest Refinery

A new refinery, to be the largest in the country, has been set for Australia. Anglo-Iranian Oil Company will build the refinery in conjunction with the Australian government-owned Commonwealth Oil Refineries. The plant is estimated to cost $66,000,000 to $89,000,000 and be capable of refining 2,000,000 to 3,000,000 gal of crude oil daily. The site has not been announced as yet, but an Anglo-Iranian spokesman said, it might possibly be an extension of the Commonwealth Oil Refineries plant at Victoria.

Lube Oil Research Set

A study directed by Dr. Ray Q. Brewster and Dr. Calvin Wenderwerf, professors of chemistry, under sponsorship of the Army Ordnance Department will direct a fundamental research plan at the University of Kansas to determine if ordinary oil can be transformed into premium lubricating oil. First, the KU researchers will try to determine the structure of high quality oil. They will then attempt to find out if the atoms in a molecule of low grade oil may be rearranged to produce a premium quality molecule.

Ethyl Corporation Opens Western Offices

The Ethyl Corporation held open house at its new western headquarters in the Western Region Building, 1141 Huntley Drive, Los Angeles, recently. Hundreds of refinery technicians and automotive engineers toured the premises during the course of the day, examining the very modern facilities that will in the future be developed to the study of engine performance in all its phases. The recently completed building has a total of 9400 sq ft of space, divided into offices, a large auditorium with a motion picture projection booth, conference rooms, shops, laboratories, and a kitchen.

Goniometer on Display. O. E. Robbins, Shell Oil Company, and I. H. Milne, Gulf Research and Development Company, center, listen as C. J. Woods, Research and Control Instruments Division, North American Phillips Company, Inc., explain the operation of a wide-range goniometer. The new machine was shown at the eleventh semi-annual X-ray diffraction school held at the company's plant at Mount Vernon, New York recently. More than 100 scientists and technical men from industry attended.

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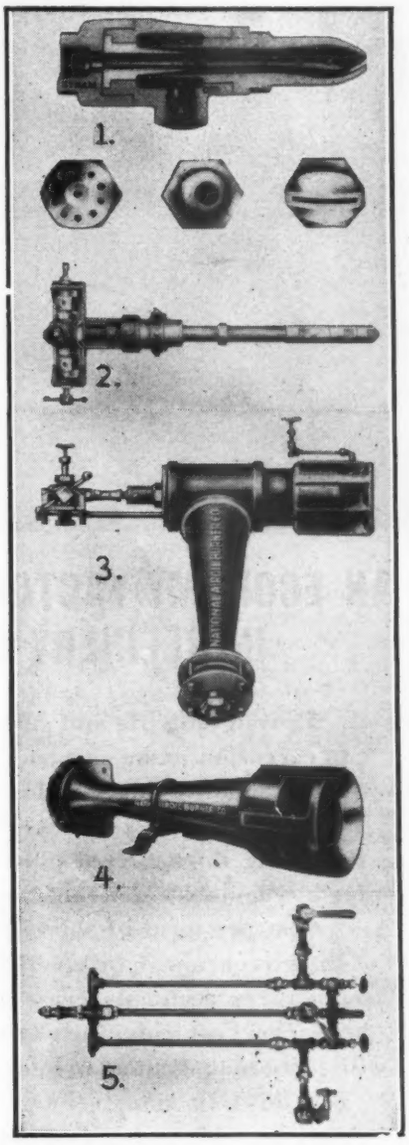

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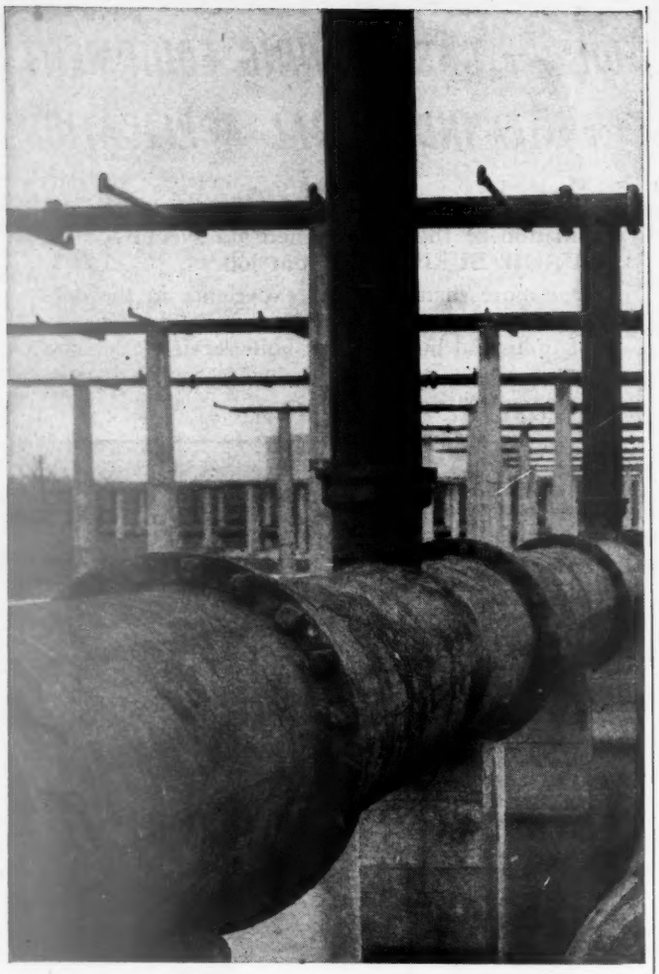


AN ECONOMY FACTOR
IN REFINERY OPERATION

Proved long life and stubborn resistance to corrosion make cast iron pipe a contributing factor in lowering plant maintenance per barrel of crude. Replacing shorter-lived pipe with cast iron pipe has demonstrated this in many refineries. Cost per term of service decreases. Interference with production, caused by frequent replacements, ceases to be a headache. Cast iron pipe works hand-in-glove with plant management to keep maintenance cost down in many refinery operations. Available with bell-and-spigot, plain end and flanged, or with standardized mechanical joints. Cast Iron Pipe Research Association, Thomas F. Wolfe, Engineer, 1015 Peoples Gas Bldg., Chicago 3, Illinois.

CAST IRON PIPE
FOR LONG LIFE AND ECONOMY

Golf Pairings Studied. Ben Symon, manager of the lubrication division of the Shell Oil Company, New York, was among the more than 50 Shell executives who attended the three-day policy and plans meeting of the company at the Grand Hotel on Mobile Bay, Point Clear, Alabama. He is shown going over plans for the golf tournament with Andy Mortimer, hotel professional player.

Esso Plans Baton Rouge Refinery Expansion

Esso Standard Oil Company plans to spend more than $35,000,000 for new construction at its Baton Rouge, Louisiana, refinery, H. J. Voorhies, general manager of the refinery, announced. The extensive construction project calls for increasing the refinery's processing capacity from 240,000 to 270,000 bbl of crude oil daily, in addition to a major expansion of its chemical operations.

With the refinery now operating at top capacity, Voorhies said the expansion program is planned to meet the nation's defense needs and the increased requirements of petroleum products for civilian and industrial consumption. Construction of the new facilities will begin immediately and is expected to take about two years for completion.

Expanded facilities will include new distillation equipment for crude oil and other petroleum fractions; expansion of fluid catalytic cracking facilities; additional equipment for processing petroleum gases to provide some of the raw materials for chemicals and materials for aviation gasoline; expanded blending and shipping facilities for gasoline, kerosine, and heating oil. Facilities for producing additional butadiene, raw material for synthetic rubber, and for increasing the refinery's output of synthetic alcohols from petroleum are also scheduled as well as equipment for the production of benzene, a chemical useful in the manufacture of synthetic rubber and plastics.

Petroleum Makes Low Cost Rubber Possible

Without the butadiene and styrene made from petroleum, man-made rubber could not be produced at its current high rate and at its relatively low price of 26 cents compared with the present Government-pegged price of 52 cents for crude rubber, is the opinion of James J. Newman, vice president of The B. F. Goodrich Company.

Speaking at a conference meeting, he said that in addition to its major contribution toward the winning of World War II, man-made rubber also has aided materially to the Nation's economic welfare in the postwar years.

The B. F. Goodrich official said that petroleum fuels have contributed immensely to our constantly improving standards of living. He pointed out that the invention of gasoline-propelled vehicles and the tremendous development of the automobile in the last half-century have changed our entire pattern of living.

—PERSONALS—

Edwin L. Marshall of New York University, New York City, and **Stan Spaulding,** Purdue University, Lafayette, Indiana, have been selected by the American Welding Society as winners of the $200 first prize and the $150 second prize, respectively, in the 1951 A. F. Davis Undergraduate Welding Award. The N.Y.U. "Quadrangle" and the "Purdue Engineer" also were awarded $200 and $150 prizes for publishing the winning papers.

"Arc Welded Tractor" was the subject of Marshall's paper, published in the March 1951 issue of the "Quadrangle". Spaulding's article, "Analysis and Design of Welded Pressure Vessels," appeared in the March 1951 issue of the "Purdue Engineer".

Frederick E. Frey, assistant research director for Phillips Petroleum Company, has been elected as chairman of the Petroleum Division of the American Chemical Society for 1952. Frey succeeds outgoing chairman B. H. Shoemaker. Other officers elected are **A. L. Lyman,** California Research Corporation, chairman-elect, and **W. F. Faragher,** Houdry Process Corporation, secretary-treasurer.

C. M. Lydy recently joined General Petroleum Corporation at Vernon, California as assistant job engineer in the engineering department. He was formerly process engineer for Socony-Vacuum Oil Company, Inc., at East Chicago, Indiana.

Bernard Goulston has been named chief staff chemist of the research department, Imperial Oil, Ltd., at Sarnia, Ontario, Canada. He was formerly assistant manager of Imperial Oil's technical-service division. Goulston joined Imperial in 1923 as a chemist at the Montreal East refinery. Three years later he went to Talara, Peru, as chief chemist with International Petroleum Company.

Goulston returned to Canada in 1927 and became chief chemist at Imperial's Ioco refinery in British Columbia. In 1936 Goulston transferred to Sarnia refinery and was made assistant manager of technical service in 1948.

W. Alton Jones, president of Cities Service Company, was elected chairman of the board for Petrochemical Corporation and **Harvey S. Firestone, Jr.,** chairman of Firestone Tire and Rubber Company, was elected vice chairman. **W. D. Gohr** was elected president. **George L. Mateer** and **Dr. John N. Street** were elected vice presidents.

The chemical company will construct one of its first plants at Lake Charles, Louisiana, to manufacture essential chemicals from petroleum hydrocarbons. Ultimately, the corporation's production will encompass the broad fields of plastics, synthetic rubber, additives for lubricating oil, anti-freeze, and many high volume petrochemicals.

A board of 12 directors was named. The directors are: Jones, Firestone, **Burl S. Watson, L. R. Jackson, H. L. O'Brien, J. E. Trainer, C. E. Weger,** Gohr, Mateer, **W. H. Price, Dr. John N. Street,** and **Roger S. Firestone.**

C. A. Pollard has been named as general manager of Standard Oil Company of California's El Segundo, California, refinery. He succeeds **E. E. Lyder,** who is retiring after 26 years with the company.

Pollard has been assistant general manager of the company's refinery at Richmond since 1940. He first joined Standard in 1916 as an oil field roustabout in Southern California. In 1919 he returned to University of Califorina and was graduated in 1921, when he resumed his job with the company.

Lyder joined the company at Richmond as a research specialist in 1925. For several years before his appointment as general manager in April 1950, at El Segundo, he had served as superintendent of the cracking division and manager of the service divisions in that refinery.

C. W. Rehfuss, formerly manager of operations, has been named to take Pollard's position at Richmond. Rehfuss, a chemical engineering graduate of Stanford, has been with the company since 1924, and at Richmond refinery since 1940.

J. T. Higgins, formerly assistant manager, operations control division, San Francisco, California, has been named manager of operations, Richmond, California, refinery for Standard Oil Company of California.

J. A. Hapke, formerly superintendent, light oil division, El Segundo refinery, will be manager, service divisions at that plant. **C. D. Lewis,** assistant superintendent, package and utilities division, El Segundo, will replace Hapke as superintendent, light oil division.

M. F. Miller, until recently manager of construction, Barber, New Jersey, refinery of California Refining Company, Standard Oil Company of California subsidiary, takes the position of assistant manager, operations control division at the San Francisco offices.

Dr. Arnold O. Beckman has been named president of the Instrument Society of America at its sixth annual instrument conference and exhibit in Houston, Texas, recently. **David M. Boyd, Jr.** and **Robert T. Sheen** were named vice presidents.

Gordon R. Henderson

Gordon R. Henderson, chief engineer of Polymer Corporation, Sarnia, Ontario, has been named general manager of the Canadian activities of Catalytic Construction Company. Henderson's headquarters will be in Sarnia. The first Canadian job of Catalytic Construction Company will be Sun Oil Company's recently announced 10,000-15,000 bbl a day refinery at Sarnia. This project, to cost in the neighborhood of $10,000,000, will include a Houdriflow catalytic cracking unit for the manufacture of high octane gasoline. Other products will be kerosine, domestic heating oil, heavy burning oil, and light hydrocarbon gases. The refinery is scheduled for completion in March, 1953.

Henderson received a bachelor of science degree with honors in civil engineering from Queen's University at Kingston, Ontario.

F. E. Caddy, formerly superintendent of Shell Chemical Corporation's Houston, Texas, plant, has been named manager of the firm's plant in Martinez, California. He succeeds **O. M. Williams,** who has been made assistant to the vice president in charge of manufacturing in New York.

A native of Wyoming and a graduate of Stanford University, Caddy joined Shell Chemical in 1931 as a laboratory assistant. He later held various technical and administrative posts in chemical manufacturing at Dominguez and Torrance, California, becoming senior technologist in Shell Chemical's San Francisco office in 1947. He was made superintendent of the Houston plant in 1948.

Harold C. Weingartner has been elected vice president and general manager of the equipment division of National Research Corporation, Cambridge, Massachusetts. Weingartner was born in Aurora, Illinois, and attended the University of Illinois where he received his B.S. in 1939. After receiving his M.S. in 1940, he was employed in the research department, Standard Oil Company (Indiana). From 1941 to 1945 he was associated with NDRC at the University of Illinois.

He joined the engineering department of National Research Corporation in 1945, and he became chief engineer in 1946. He held this position until his recent promotion.

▸ **Dr. A. Lewis, Jr.,** has been appointed chief product engineer in the motor lubricants and additives section for Gulf Oil Corporation. He is on transfer from the Gulf fellowship at Mellon Institute, where he has been an assistant to Dr. W. A. Gruse, administrative fellow, petroleum fellowship, Mellon Institute. Dr. Lewis recently secured his Ph.D. in chemistry from the University of Pittsburgh. During World War II, Dr. Lewis served as an engineering officer with the United States Navy, with the rank of lieutenant, and previous to that was with Gulf's refinery technology laboratory at Philadelphia.

Robert L. Grun has been appointed chief product engineer, industrial lubricants and specialties section, on transfer from industrial products engineering, where he served as chief fuels and lubricants engineer, process oil section. Grun has been with this department since his release from the United States Navy in May 1946, where he served as an engineering officer with the rank of lieutenant commander. Prior to his naval service, Grun was with Gulf Oil Corporation's technology laboratory at Philadelphia.

In automotive products engineering **H. H. Donaldson** has been transferred from chief fuels and lubricants engineer, equipment section, to chief fuels and lubricants engineer, marine engine section. Prior to this transfer to product engineering, Donaldson was in charge of engine testing of lubricating oil, Gulf Research and Development Company.

R. P. Gilmartin has been appointed to chief fuels and lubricants engineer, equipment section, succeeding Donaldson. Prior to his transfer Gilmartin was with the chemistry division, Gulf Research and Development Company.

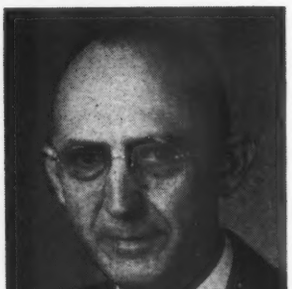
Under industrial products engineering **R. L. Nix** has been appointed chief fuels and lubricants engineer, process oil section, succeeding Grun. Nix formerly worked in the chemistry division, Gulf Research and Development Company. All of the above named men will be in the company's general offices, Gulf Building, Pittsburgh.

Dr. W. E. Elwell

▸ **Dr. W. E. Elwell** has been appointed manager of Eastern product development of the Oronite Chemical Company, a wholly-owned subsidiary of Standard Oil Company of California. His headquarters will be at 30 Rockefeller Plaza, New York City. Formerly supervisor of chemical products for California Research Corporation, another wholly-owned subsidiary of California Standard, Dr. Elwell has a detailed knowledge of organic chemicals currently being developed by Oronite.

Dr. Elwell was graduated from the College of Puget Sound with a B.S. degree in 1933 and received his Ph.D. degree at the University of Washington in 1938. He has worked for Standard Oil of California and subsidiaries for the past 13 years.

▸ **Dr. Thomas R. Steadman** has joined the petrochemical research department of National Research Corporation, Cambridge, Massachusetts. Dr. Steadman received his B. S. in chemistry from Rensselaer Polytechnic Institute in 1937. In 1941 he received his Ph.D. in organic chemistry from Harvard University, and in 1940 and 1941 he acted as private assistant to Professor W. M. Lauer at the University of Minnesota.



M. L. Cobb

▸ **M. L. Cobb,** superintendent of the lubricating oil division, in Continental Oil Company's Ponca City, Oklahoma, refinery, has been promoted to the newly created position of director of training for the company's manufacturing department, Cobb is a graduate of Oklahoma A. & M. College and joined Continental at Ponca City in 1925. His entire tenure with the company has been at Ponca City, where he has moved up through promotions in the manufacturing department.

He became superintendent of the power division in 1940, foreman of the solvent treating unit in 1943 and general foreman of the lubricating division in February of 1948. He was promoted to superintendent in June of the same year.

▸ **Chalmer Gatlin Kirkbride,** vice president and director of Houdry Process Corporation, has been chosen to receive the 1951 Professional Progress Award in Chemical Engineering, sponsored by Celanese Corporation of America. The award which carries with it a prize of $1000, is administered by the American Institute of Chemical Engineers, and will be given at the organization's annual meeting this December at Atlantic City. Kirkbride was cited "For his many contributions and gifted leadership in chemical engineering education and practice, for his scientific developments underlying petroleum technology, and for his tireless and unselfish service to the Profession."

Chalmer Gatlin Kirkbride

▸ **Richard D. Mullineaux,** who recently received his Ph.D. in organic chemistry from the University of Wisconsin, has joined the staff of Shell Development Company.

Ross E. Van Dyke, formerly instructor in chemistry at Johns Hopkins University, has joined the staff of Shell Development Company and is working in the colloid chemistry field. Van Dyke, holder of a Ph.D. degree in chemistry from Brown University, received his undergraduate training at Gettysburg College and was connected with the Manhattan project during World War II.

A. B. Bullock of Shell Development Company, Emeryville, is at New York University where he is studying recent developments in the field of microchemical analysis. He plans to return to the laboratory early in 1952 and will be in charge of microanalytical work at Shell Development. Bullock, a graduate of the University of California in 1934, has been with Shell Development for 15 years.

John A. Buckland and **Howland A. Larsen** have joined the development staff of Shell Development Company. Buckland recently received his Ph.D. in chemical engineering from Pennsylvania State College, and Larsen holds a M.S. in chemical engineering from the University of Illinois.

▸ **James L. Vaughan** has been appointed director of the process engineering department at National Research Corporation. Vaughan received his S.B. in chemical engineering from the Massachusetts Institute of Technology in 1936 and his S.M. in 1937. From 1937 until 1943 he was employed as a chemical engineer by Standard Oil Company (New Jersey). Subsequently he worked for Shell Chemical Corporation as chief technologist at their Dominguez and Martinez plants. He left Shell to become assistant professor of chemical engineering at Rhode Island State College, Kingston, Rhode Island.

Oil Pipe Line Operating Pressure Practices

Practicable method to determine correct working pressures for pipe of various weights and tensile strengths

F. C. WHITESIDE

For many years in the pipe line industry only so-called standard weights of pipe were used except in unusual circumstances. The unusual circumstance usually meant that the standard weight was not available and a thinner walled casing of some kind was used. There were several factors that supported the custom of using what has now proved to be excessive steel in pipe lines:

1. It was felt that the thick walls were justified because of added time of trouble-free service from corrosive causes.
2. The physical strength of steel was far below that being used today in pipe fabrication.
3. The processes of pipe fabrication sometimes left points of weakness in the longitudinal seam.
4. It was felt that the screw lines, which were the order of the day up to 20 years ago, required extra thickness so that the cutting away of steel threading would leave sufficient thickness to hold the longitudinal stress from temperature expansion and contraction.

The standard weights for the sizes of pipe customarily used for crude lines in the early days are tabulated below:

Pipe size, OD, in.	Wall thickness, in.	Weight, lb/ft
4½	0.237	10.79
6⅝	0.280	18.97
8⅝	0.322	28.55
10¾	0.365	40.48
12¾	0.375	47.56

When the practice of welding pipe invaded the oil fields, these so-called standard weights of pipe were quite well established. Despite the benefits and economies of the thinner walls, many companies continued the use of the heavier pipe wall well into the era of welded lines. A few companies still use the standard weights.

Pipe lines in general may have been slower in modernizing their practices than some other lines of industry. One of the reasons for this could be the large profits earned by the pipe lines from the beginning of that means of transportation. The high cost of overland transportation of oil by any means other than pipe lines made pipe line rates look cheap in comparison. Paying large profits to their owners and charging rates that were relatively low, pipe lines were under comparatively little compulsion to amend operating practices or to originate new ones.

The first welding used on pipe lines was not such as to instigate an increase in operating pressures. The early oxyacetylene process is one that inherently involves several delicate balances. Careless welders, allowing an improper mixture of the oxygen and acetylene in the welding torch, frequently left porous and badly weakened joints in the lines. Occasional failures of these weak joints tended to retard the trend toward a decrease in pipe wall thickness.

The development of electric welding gave a much more reliable joint than the older gas welding process. Shielded arc welding more effectively excludes the air from contact with the molten metal, and thereby reduces the occurrence of partly oxidized iron in the weld. The electrically welded joint was one of the first of several improvements that pointed toward higher operating pressures and thinner walls.

Other improvements followed quickly. Of major importance is improved steel and improved methods of manufacture, which produce pipe materially stronger than the pipe of 20 years ago. Prior to that time the bulk of cross-country oil line pipe was manufactured by the old lapweld process. The development of the seamless process of manufacture using grade B steel (35,000 psi minimum yield) provided a better pipe for the industry. With the seamless process the pipe is hot rolled to size on a mandrel. It was a big step forward, but the process is subject to some important limitations tending to oppose a sustained higher pressure, thinner wall trend:

1. Difficulty in maintaining acceptable tolerance in wall thickness in the thinner sizes.
2. Difficulty in making both ends of thin wall joints near enough the same size that serious field line-up problems are not introduced.
3. Being essentially a hot forging process the steel was left in an annealed condition so that its final strength could not include an increase from cold work.

In 1927 one of the leading pipe manufacturers pioneered two processes in pipe fabrication that were destined to push these limitations back and provide the pipe line design engineer with more freedom of discrimination. They were the electrically welded seam and cold expansion of the joints to size. A unique flash welding process of their own design delivered a product of equivalent reliability to seamless pipe, (no instance of failure of their flash welded seam has ever come to the attention of the writer), and the rolling tolerance of the plate mill became available to the pipe industry. Cold expansion to size raises the yield so that the plate might go in as grade B at 35,000 psi minimum yield and come out as pipe stronger than that. Pipe made by this process ranged upward from 8-in. in size.

Advances in steel chemistry during the next decade increased the strength of the plate available for pipe manufacture so that by the early 1940's pipe was being produced whose minimum yield strength was 42,000, 45,000, and even 52,000 psi as compared to the previous top quality grade B at 35,000 psi. The API code fell behind and the stress of war-time demands prevented adjustment of the code and the industry to the leaders in the field. By the time the API code was revised in 1949 to give cognizance to the improved technology, several other manufacturers had entered the electric weld-cold ex-

The Author

F. C. Whiteside is chief engineer of the Continental Pipe Line Company. Before joining Continental on March 1, 1950, he was assistant chief engineer of Interstate Oil Pipe Line Company. Whiteside received a BS degree in electrical engineering from the University of Oklahoma, and began his pipe line career with the Oklahoma Pipe Line Company, transferring to the Carter Oil Company in 1938. He went to Venezuela in 1941 as safety engineer with the Standard Oil Company of Venezuela. In 1943 he moved to Atlanta, Georgia, on assignment to the Plantation Pipe Line Company, and in 1945 transferred to the engineering department of Interstate.

EXCLUSIVE

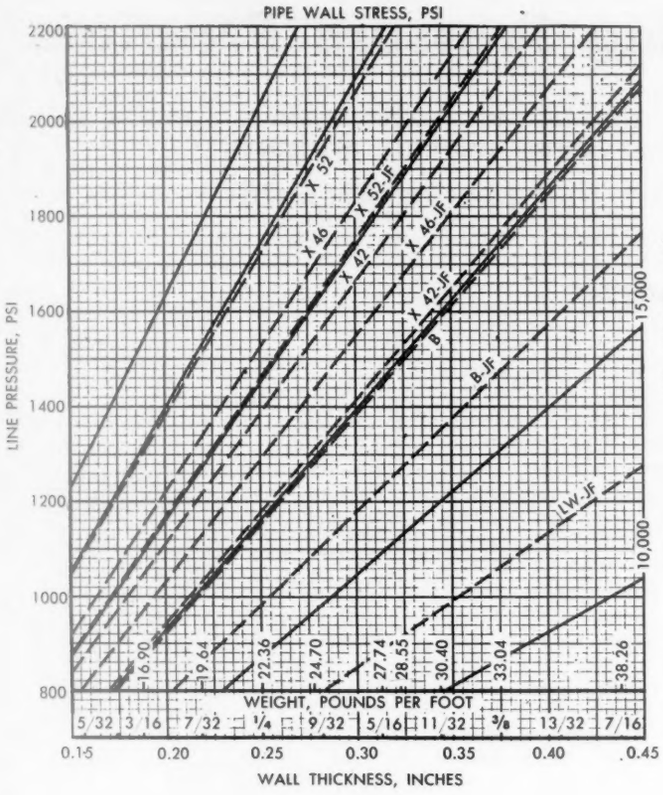


FIG. 1. Working pressure chart. 8.625-in. OD pipe.

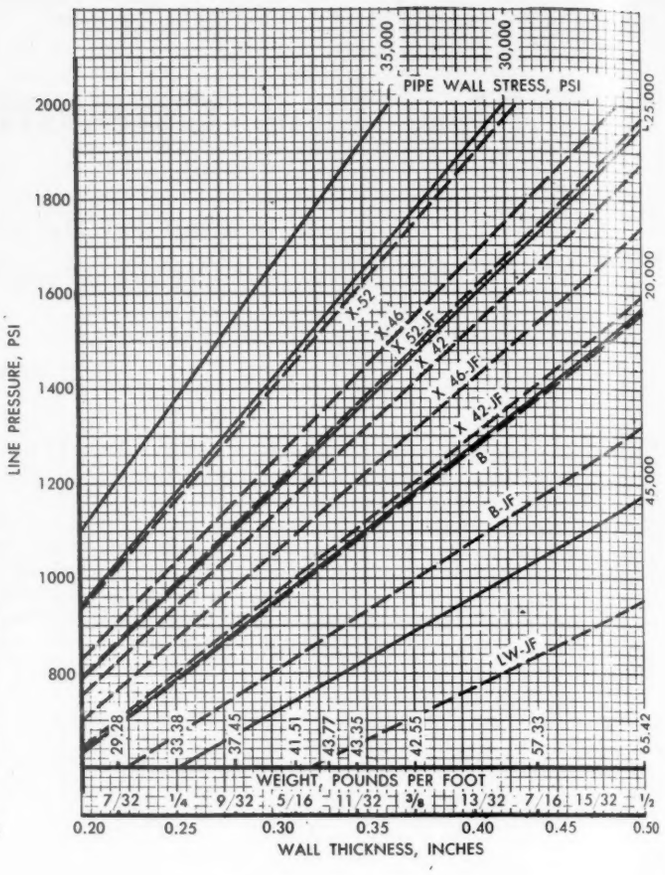


FIG. 2. Working pressure chart. 12.75-in. OD pipe.

pansion field applying other innovations in the process.

Improvements in corrosion prevention were needed also to give impetus to the lighter wall thickness trend and they were forthcoming during the last 15 years and mostly during the last 10; methods of corrosion mitigation for pipe lines have made such rapid progress that the feeling of need for additional thickness for corrosion protection has been rapidly dissipated.

The result of all these improvements within the last 15 years was to provide the materials and methods by use of which economies in pipe line operation and investment were possible. The driving force dictating the application of these improvements arrived in the form of a long time and continuing downward trend in tariff rates, coupled with ever-increasing costs. Pipe line profits were reduced to such an extent between these pincers that pipe line design and methods of operation came under close economic scrutiny.

By far the greatest part of the investment in a pipe line system is in the lines themselves. It is only natural then that one effect of economic pressure should be the reduction of steel to only what is needed (the reduction of this major part of investment) and another effect, higher operating pressure (a fuller use of this major part of investment), and the trend to lighter walls and higher tensile stress is on in earnest.

In the old days of loose design and operating practices, it was common to speak of operating pipe lines at a safety factor of 3, 4, or 5. This safety factor was based on the ultimate bursting strength of the pipe and had no direct relation to the stress at which the steel would yield. The recent trends tending to raise operating stresses and at the same time decrease pipe wall thickness require a better basis upon which to design pipe lines efficiently, and the old safety factor related to bursting pressure was discarded.

During the first part of the last 10 years little uniformity emerged. The 1942 edition of The Code for Pressure Piping by The American Standards Association attempted to bring order out of the confusion and based their pressure ratings on the yield. Their pressure ratings, however, included an arbitrary factor for "mechanical strength and corrosion." The advancement in corrosion mitigation practices has provided the pipe line designer with measures for economically preventing corrosion damage through a considerable life period. Pipe line engineers consequently came to feel that a factor in the pressure rating to allow for weakening by corrosion was unjustifiable. Leaving out the factor resulted in pressure ratings that proved to be too high for general industry acceptance, although a few companies designed lines and operated them on this basis under the stress of war-time conditions. Most of the oil lines laid since the war have been designed somewhat on a common basis rather below the specifications of the 1942 Code for Pressure Piping and they have operated long enough to demonstrate that the basis is sound. The following is a good cross-section of that basis:

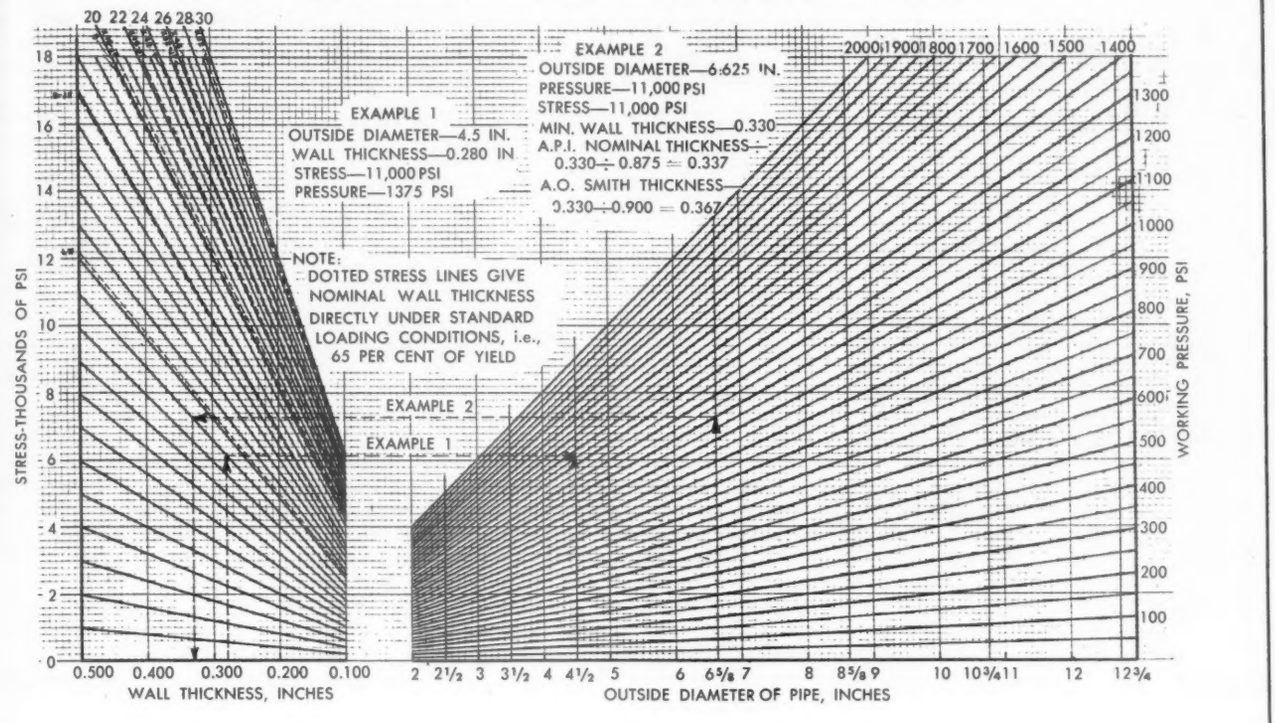
1. That rolling tolerance (12½ per cent or 10 per cent as the case may be) be subtracted from the nominal wall thickness leaving effective thickness to withstand the pressure.

2. That working pressure be such as to produce 65 per cent of the yield stress in the effective thickness.

3. That 15 per cent be subtracted from this pressure as a joint factor for electric welded pipe except in the following cases:

   a. Pipe whose process of manufacture included cold stretching beyond the yield.
   b. Pipe not cold stretched but manufactured by a welding process such as the submerged arc operating over a back-up shoe or roller so that the entire area between the plate edges is melted out.
   c. Pipe not cold stretched but whose fabrication process includes inspection procedures capable of

FIG. 3. Pipe size and pressure relationship to steel stress and thickness.



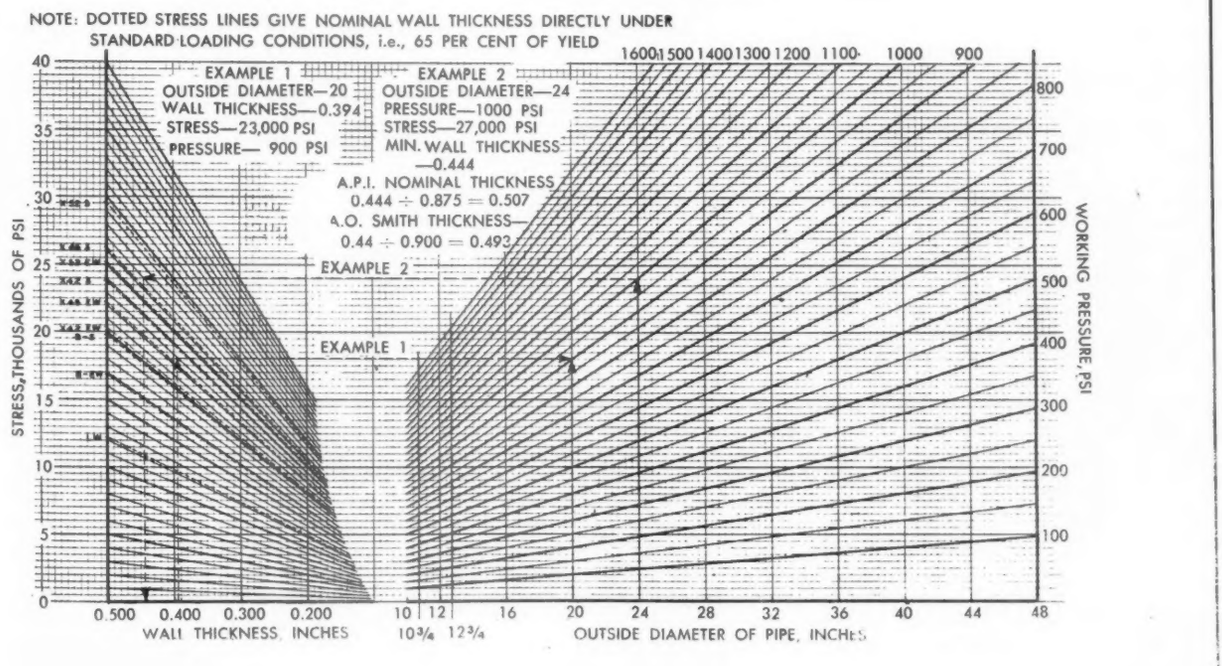
disclosing the existence of minute cracks in the weld area, such as magnifluxing.

4. That 35 per cent be subtracted for joint factor on lap or butt welded pipe.

A considerable number of oil pipe lines have been laid within the last few years on a little more liberal basis of loading design than shown here. They left out the first item where credit is taken for the variation of steel thickness allowable under the rolling tolerance specification.

Reliability of this code is strengthened materially by the fact that wall thicknesses particularly on electric welded pipe rarely vary more than half the rolling tolerance and also because practically all the pipe will test higher than the minimum yield. For example, practically all samples from pipe specified to be 52,000 psi minimum yield will test 55,000 psi to 60,000 psi.

FIG. 4. Pipe size and pressure relationship to steel stress and thickness.



Of course there are several possible errors in the factors involved in testing and calculation. For example:

1. Pipe coupons are cut from circumferential positions in pipe walls and are usually straightened out while cold in order to place them in the pulling machine. This cold working would tend to raise the tensile strength.

2. The Barlow formula generally used for calculating wall stresses in pipe under pressure is an approximation. The error is on the side of conservation, however, so that an offset to the error resulting from cold work in the sample is introduced.

3. Samples torch-cut from a pipe wall are subject to an annealing effect that tends to relieve locked-in stresses from cold work and in general lower the yield point.

There are others, but the purpose of this discussion is not to evaluate the technicalities of testing but to propose a demonstratedly practical basis of pressure loading for oil pipe lines, the practicality of which is demonstrated by a number of applications in satisfactory services designed on a basis approximating these conditions. The practice in the oil transportation industry has stabilized to such an extent that it should be valuable in backing up the next code revision.

Graphs shown in Figs. 1 and 2 illustrate a convenient form for arriving at the correct working pressure for 8-in. and 12-in. pipe respectively, for various weights and tensile strengths. Figs. 3 and 4 are composite charts for the range of pipe sizes shown on each. The curves on these graphs are based on the pressure rating specifications of this report.

The trend toward higher operating pressures and thinner walls of necessity dictated that effort be made to evaluate what the optimum value of these features should be when a system was being designed. Those values for each pipe size vary as the balance shifts between cost of steel, station operating cost, and income tax rate. Increase in the cost of steel tends to lower the optimum pressure for a given pipe size. increase in station operation costs tends to raise it.

The optimum pressure for the larger lines such as have been laid so extensively in recent years is now equal to or above that at which the older small lines were operated. The operating pressure for the smaller lines has advanced on beyond as efforts are made to make optimum use of this major part of investment. Specifically, 8-in. lines have been designed to operate at pressures of apparently 2000 psi. Pipe line pressure may be expected to advance beyond even that as the industry should evaluate the economic possibilities of small lines that are capable of withstanding such pressures without adding materially to the steel in the pipe walls in the transportation of volumes appropriate to their capacity. * * *

P 615.9

How to Determine Truck Battery Requirements

J. E. VAUGHAN

DETERMINATION of capacity of storage batteries that power electric industrial trucks is often left to the truck supplier, the battery representative, just plain guess, or duplication of present batteries. There is an engineering procedure, however, which, if followed, will enable the purchaser to correctly specify his own battery requirements or check suppliers' recommendations. In addition, these calculations will insure against purchasing under-capacity batteries that run down before the end of the shift, or conversely, over-capacity batteries calling for unwarranted initial cost.

To illustrate the procedure for determining industrial truck battery capacities we will assume a typical case—a 3650-lb truck, 2000-lb load, 3-ft average lift, 110-ft average haul, and 30 ft 10 per cent grade to be traversed by loaded trucks.

It will be necessary to determine the power (watt hours) required to traverse the average haul distance loaded, climb the grade, traverse the haul distance empty (grade deducted), lift the load for stacking, and tilt the mast for load-centering.

Fig. 1 indicates the watt hours per ton required to move a truck along a given length of *level* run. We can use this graph to determine the power required to travel the average haul distance. By following the dotted lines we see that 5.4 watt hours are required to haul 1 ton along the 110-ft haul of our example. Our total load is 3650 lb (truck) plus 2000 lb (load)—5650 lb, or 2.825 tons. Multiplying 2.825 tons by 5.4 watt hours gives 15.25 watt hours required for the level run.

*Supervisor Field Engineering, Gould-National Batteries, Inc.

We can determine the watt hours required for going up grade (in addition to that required for level running) by using the formula: Watt hours = tons (truck plus load) × ft (length of grade) × grade (per cent) × 0.013 (a constant). 2.825 tons × 30 ft × 10 × 0.013 = 11.02 watt hours (extra power for grade).

Then to calculate watt hour requirements for the empty return trip, deducting the grade, we have the 110-ft total return distance less the 30 ft of grade, or 80 ft. Again using the graph (dashed lines), we see that 4.4 watt hours are required per ton on the return trip. As the weight is now 1.825 tons, we multiply 4.4 watt hours by this figure, getting 8.03 watt hours.

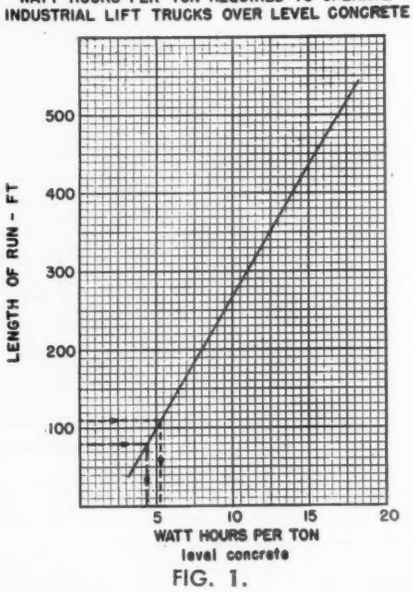


FIG. 1.

To determine the watt hours required for lifting, we use the following formula: Watt hours per lift = tons of load × ft of lift × 2 (a constant). Thus. 1 ton × 3 ft × 2 = 6 watt hours required to lift the load. (For unstacking, the following formula applies: Watt hours per lift empty = ⅓ load capacity in tons × ft of lift × 2.)

To determine the energy required to tilt the mast, we use the following formula: Watt hours per tilt loaded = tons of load × 1 (a constant). Thus 1 ton × 1 = 1 watt hour per tilt loaded. (Watt hours per tilt empty = ⅓ load capacity × 1.)

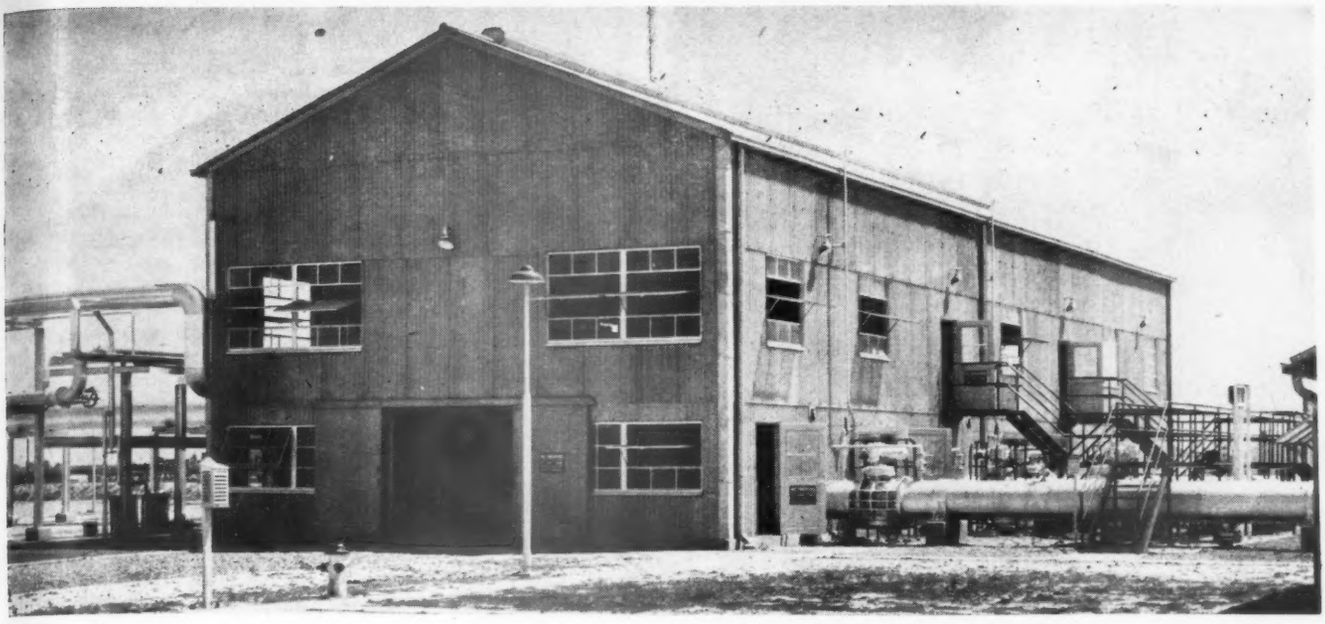
Summing up we have:

Run with load, no grade	15.25 watt hr.
Extra power for grade	11.02
Run empty, grade deducted	8.03
Power required per lift	6.00
Power required per tilt	1.00
	41.30 watt hr per trip

Assuming 250 trips per day, a total of 10,325 watt hours of battery power are required. If we select a 32-volt battery, as recommended by truck manufacturers for this size truck, it must have approximately 323 ampere-hour capacity. (Ampere hours equal watt hours divided by volts, hence the ampere hours required equals 10,325 watt hours divided by 32 volts or 323 ampere hours.) Battery manufacturers' catalogs give ampere hour capacities of various sized cells.

By following this procedure, the purchaser can effect economies that will be reflected in multiple because future purchases of batteries for given applications will be based on original computations.

Formulas used are from the Handbook of Material Handling published by the Electric Industrial Truck Association, 1950. * * *



Compressor building at Eunice, Louisiana.

Steam Turbo-Compressor Stations

Now for first time steam-turbine-driven centrifugal compressors are in use on a gas transmission system

H. LEE NORRIS, JR.

PART 1

A RADICAL departure from the usual transmission pipe line practice is the use of centrifugal compressors driven by steam turbines at three of Transcontinental Gas Pipe Line Corporation's 19 compressor stations. These installations, recently completed, are at Station No. 5 near Eunice, Louisiana; Station No. 7 near Tylertown, Mississippi, and Station No. 10 near Billingsly, Alabama.

The decision to incorporate steam-driven centrifugal compressors was made in an effort to realize lower capital cost per installed horsepower, lower maintenance, lower lubricating oil consumption, and lower operating costs over the conventional gas engine type compressor.

Studies have indicated that these stations should consume approximately 15 per cent more fuel gas than their equivalent reciprocating engine stations, but that the other factors mentioned should more than offset this increased fuel consumption and give a more economical gas pumping unit.

EXCLUSIVE

The plant layout of these stations was made to provide a complete independent operating unit capable of supplying all of its auxiliary services, including power, water, maintenance, living quarters, etc. The boilers, generating steam to drive the centrifugal compressors, and electric generating unit, are housed in a separate building. Steam and electric service are fed into the compressor buildings; the separation being made to eliminate fire hazard, should a gas leak occur in the vicinity of the compressors.

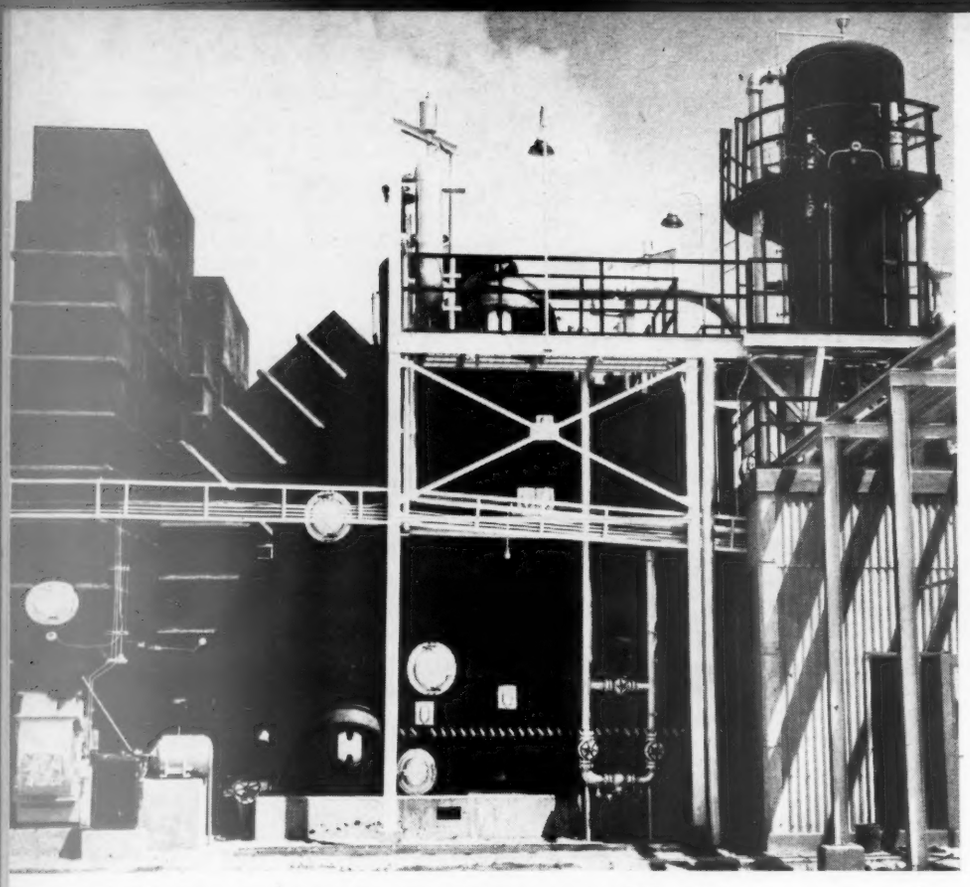
The Author

H. Lee Norris, Jr., is a graduate of Texas Technological College, Lubbock, Texas, with a B.S. degree in mechanical engineering (1937). He is a member of Tau Beta Pi Association and the American Society of Mechanical Engineers, and a registered professional engineer in the State of Texas.

After graduation and until 1939 Norris was a student engineer for General Electric Company. While on the General Electric Test Course he tested a-c and d-c apparatus and steam turbines of all sizes and types.

From 1939-1940 he was an operating engineer with Pacific Gas and Electric Company, San Francisco, California, in their high pressure steam-electric plant. He spent the years 1940-1943 with the Elliott Company, Jeannette, Pennsylvania, as the engineer for designing and testing centrifugal blowers and steam turbines. The two years, 1943-1944, saw Norris as the power engineer with Dow Magnesium Corporation, Velasco, Texas, in charge of the high pressure steam-electric plant.

The U. S. Navy employed Lieut. Norris in its Rocket Development Program in 1944-1945. After World War II he returned to the Dow Chemical Company, Freeport, Texas, as project engineer in charge of the steam power, water, gas process, and disposal projects. In 1950 Norris joined the Fish Engineering Corporation as engineer in charge of design and installation of steam-turbine-driven centrifugal compressor stations.



These boilers are designed to operate at a pressure of 700 psi.

Flexibility of these compressor installations is achieved primarily by speed control of the centrifugal compressors, and secondarily by the cutting in and out of individual compressors. The entire pipe line flow goes through each compressor and the pressure rise, or ratio, depends on the speed of the unit or units. The pressure regulators control the speed of the turbines automatically in response to discharge pressure. The turbine speed governors are set to act as limiting devices to prevent excessive speeds from damaging machines or overpressuring the pipe line.

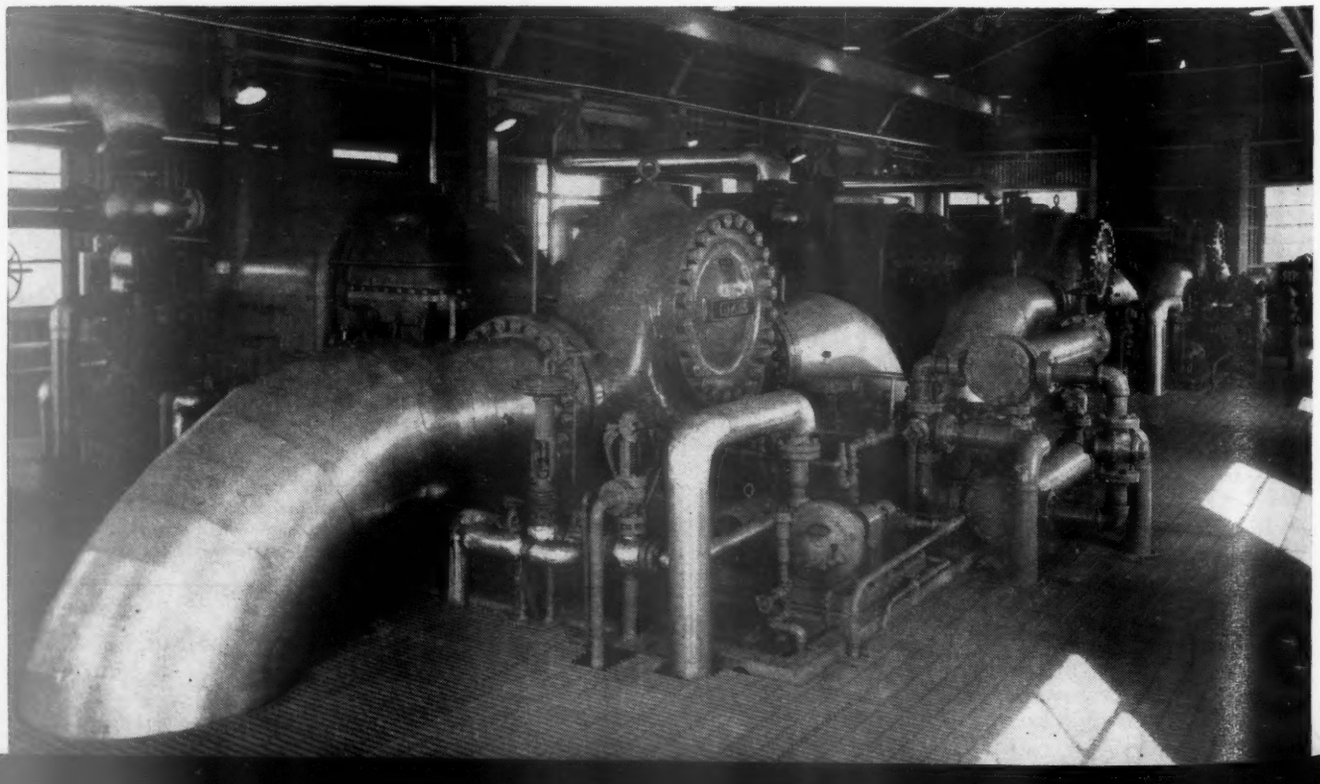
The boiler installations, all of which are similar, consist of three semi-outdoor boilers, each designed to deliver under normal operating conditions 43,000 lb per hr steam at 600 psig and 750 F. Each boiler is served by motor-driven forced and induced draft fans and has complete automatic combustion and feed water control. The boiler buildings house the boiler auxiliaries and the electric generating and switching facilities. All motor starters are in the boiler building and are of the conventional open type used in non-hazardous areas.

The boiler feed water, which is condensate, is heated to 259 F in a deaerating heater and pumped into the boilers through motor-driven vertical shaft boiler feed pumps. The electric power is provided by two 800-kw, 0.8-PF, 5500/-1200 rpm geared turbine generator sets, generating at 480 volts. The turbines for these generators take steam at 600 psig, 750 F, and exhaust at 20 psig directly into the deaerating feed water heater. At full load only one turbo-generator is required to be on the line and there is almost a perfect balance between electric energy demand and feed water heating steam demand. However, an excess steam condenser to dispose of excess steam and an automatic reducing valve to make up a steam deficiency are provided for periods of unbalance between electric energy and heating steam demand.

The makeup water to the steam cycle is conditioned through demineralizer units that employ two-stage ion exchange beds to reduce total dissolved solids in the water to 10 parts per million and not more than 0.2 parts per million silica. As this method of treating water is rather expensive, particular care has been made to recover all the steam and condensate, and it is estimated that the total makeup for these stations will be less than 1 per cent of the boiler steam flow. Boiler outages are generally due to either poor water or slagging and refractory trouble. The fuel for the boilers is gas taken from the pipe line and, hence, no slagging or refractory trouble should develop. Demineralized water in the boilers should enable them to be operated with a minimum of downtime, perhaps only once per year for inspection.

The steam header is of all-welded construction with weld end pressure seal bonnet valves to preclude any trou-

Compressors and turbines at Billingsley.



ble from flanged joints. No isolating valves are provided other than boiler lead and turbine lead valves.

The compressors themselves were purchased as "Package Units" and consist of steam turbine, centrifugal compressor, and surface condenser with the surface condenser forming the foundation for turbine and compressor. The compressors are piped up to operate in series, taking the entire pipe line flow through each compressor. One noteworthy feature of these compressor stations is the absence of gas scrubbers and coolers. Small particles of dust or liquid coming through with the gas, which is detrimental to valves on a reciprocating compressor, are passed through the centrifugal compressor without harm, hence, the necessity of inlet gas scrubbers has been eliminated. The centrifugal compressor is inherently a high capacity, low ratio device and, for this reason, the discharge temperature is relatively low; the discharge temperature being approximately 130 F based on 60 F inlet gas temperature. The combination of the compressor characteristics is such that the discharge gas temperature cannot exceed a temperature that would damage the pipe line coating material or cause undue stress in the pipe wall. For these reasons, gas coolers have been omitted and the pipe line itself does the gas cooling.

The individual nameplate ratings for the centrifugal compressor-steam turbine-condenser units are slightly different at each station. The nameplate ratings for Station No. 7 are given as follows:

Three Units Operating

Inlet pressure	516.5 psia
Discharge pressure	819 psia
Rpm	4500
Shaft hp	14,830
Steam flow	106,250 lb per hr.
Specific gravity	0.6
Specific heat ratio	1.275
Inlet temperature	60 F
Capacity	603.10 MM std cu ft per day at 60 F and 14.73 psia.

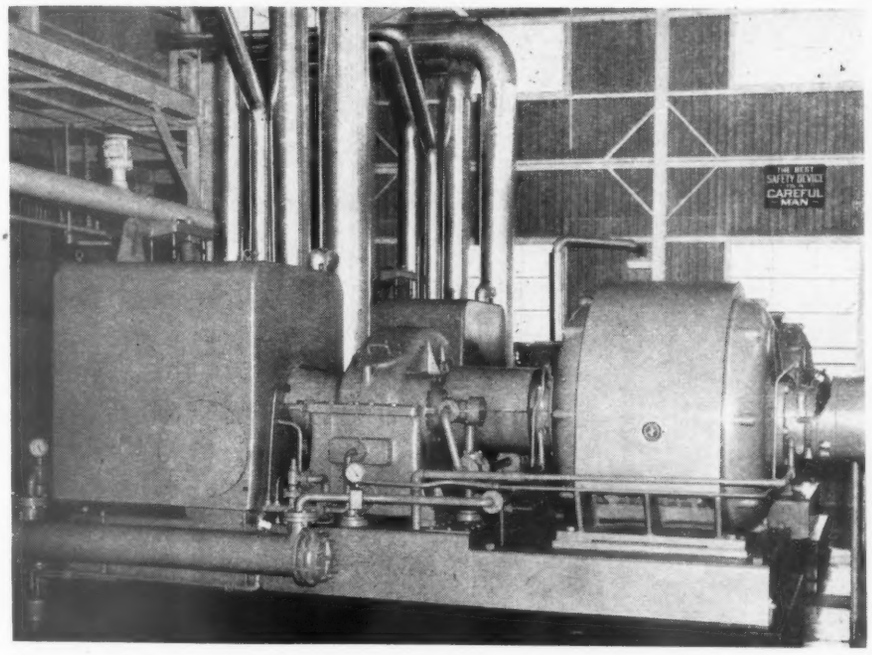
Two Units in Series

Inlet pressure	562.5 psia
Discharge pressure	819 psia
Rpm	4800
Shaft hp	11,200
Flow	564 MM std cu ft per day

This performance is based on absolute pressure at turbine exhaust of 2.5 in. of Mercury.

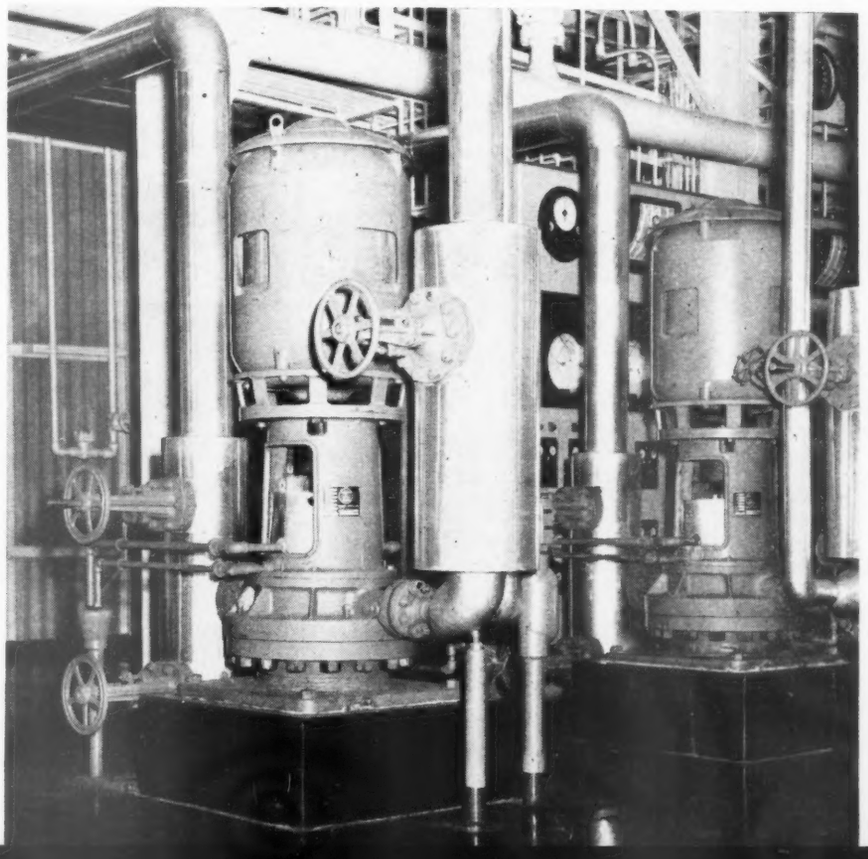
The surface condensers are served by conventional induced draft cooling towers with vertical motor-driven circulating pumps suspended in the cooling tower basin. The circulating water lines to and from the cooling tower are carried overhead.

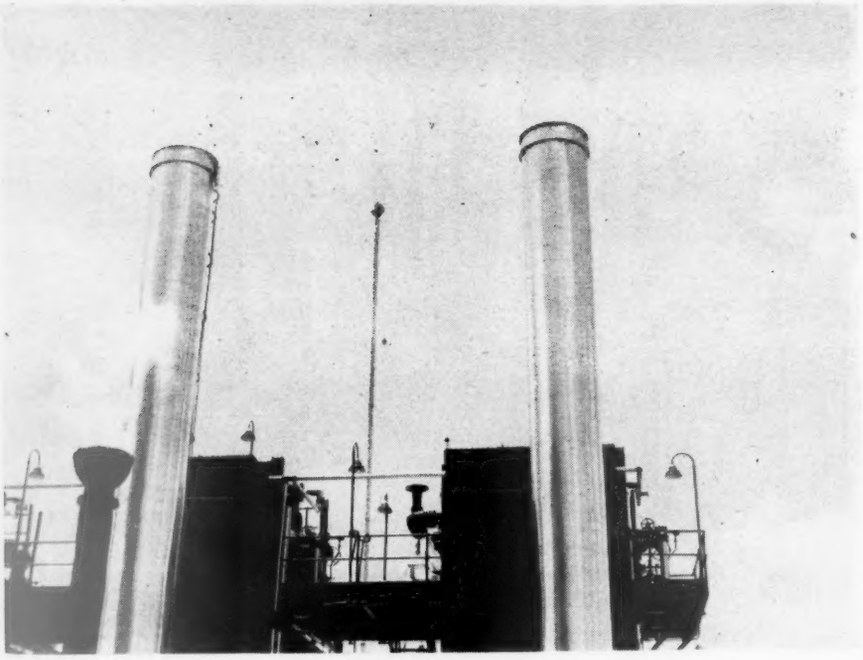
The steam turbines used are multistage condensing units of the type used in smaller steam electric generating stations, except that they have higher rotating speeds. The centrifugal compressors are all single-stage machines with heavy cast-steel casings. Thermodynamically they are no different from the single-stage centrifugal compressors that have been used for low pressure, high capacity air and gas service for many years. The main difference is that they have heavy cast-steel cases and are equipped with oil type gas seals. These seals differ with each make of compressor, but generally they may be described as adaptations of journal bearings or thrust bearings. The journal bearing type consists of narrow journal bearing having oil at a pressure a few pounds higher than the gas pressure supplied to them, whereby a small amount of oil leaks into the gas space and is collected by a slinger and sump arrangement. The thrust bearing type gas seal has a carbon ring continuous for 360 F applied to a runner where the thrust shoes of a thrust bearing would be. Here again, oil under pressure higher than gas pressure is supplied, and oil leakage through the seal is collected by the slinger and sump arrangement. Early operating experience indicates that the oil consumption of these seals will be negligible, thereby eliminating the use of a large quantity of lubricant and, what is perhaps more important, keeping this oil out of the line where its accumulation would tend to restrict flow.



Steam turbine generator driven by an electric motor.

Boiler water feed pumps.





New techniques in gas transmission are symbolized in this picture. The boilers and stacks at Transcontinental's Billingsley, Alabama, station frame the microwave radio tower.

The seal oil system which is designed to supply a continuous and unfailing flow of oil to these seals, consists essentially of motor-driven pressure pumps installed in duplicate, necessary filters, differential pressure regulator to regulate oil pressure, and an emergency overhead oil tank to supply oil for a sufficient time to allow a unit to be shut down in case of failure of any of the other sealing oil apparatus.

The design of the 30-in. gas piping in the vicinity of the compressors presented some unusual problems. The piping requirement is that any compressor be able to operate singly and that any combination of compressors be able to be operated in series. Each compressor has its separate inlet and discharge valve and has a bypass valve around it. These valves are 30-in. by 24-in. weld end plug valves equipped with electric operators. Motor-operated plug valves were chosen for their rapidity of operation. The station side gates and block valves are 30-in. full opening weld end motor-operated gate valves. A 30-in. by 24-in. weld end check valve at each station prevents backflowing the station.

The 30-in. OD pipe size was maintained up through the short risers to and from the compressor inlet and discharge flanges. Reduction in pipe size to fit compressor flanges was made through 24-in. by 30-in. weld elbows and appropriate conical reducers.

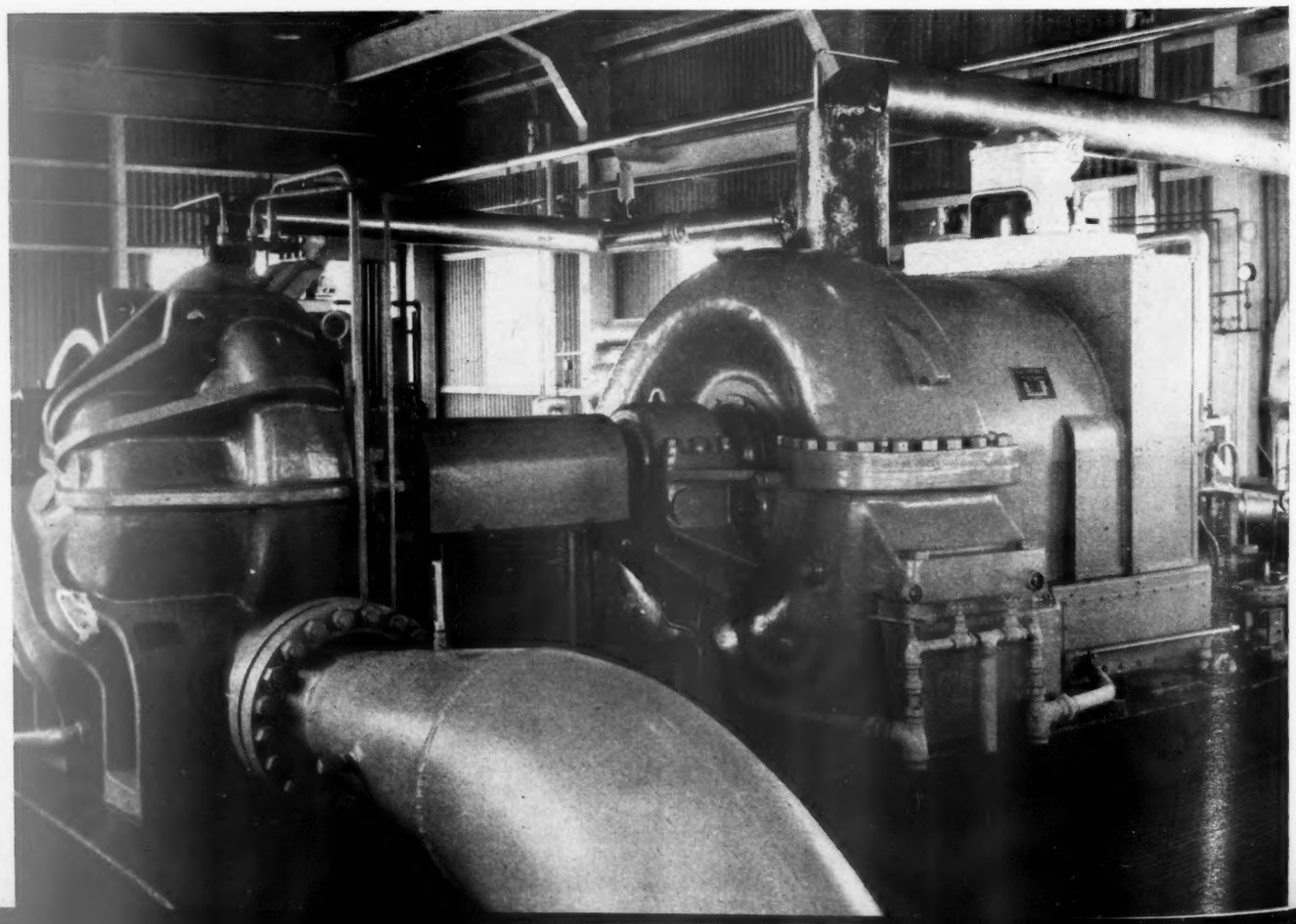
Expansion forces of the pipe are allowed for by suitable anchors of special design at each compressor and by large bends to give flexibility. Exhaustive studies were made of the piping design to make certain that the compressors would not be pushed out of alignment under operating conditions. The 30-in. gas piping is of all-welded construction except for flange connections to the compressors. All welds were proved by X-ray examination. All steam and gas piping conforms to the ASA Code for Pressure Piping.

Water for cooling tower and general station use is produced from deep wells at Stations 5 and 7. Station 10 produces its water from nearby Little Mulberry Creek.

These stations represent a departure for transmission gas pipe line work, but consist of well proved types of equipment that has been used for many years in industry. They were designed by The Fish Engineering Corporation and built by Fish Constructors. * * *

(Part 2 Will Be Published Soon.)

One of the steam turbines and centrifugal compressors at the Eunice station.



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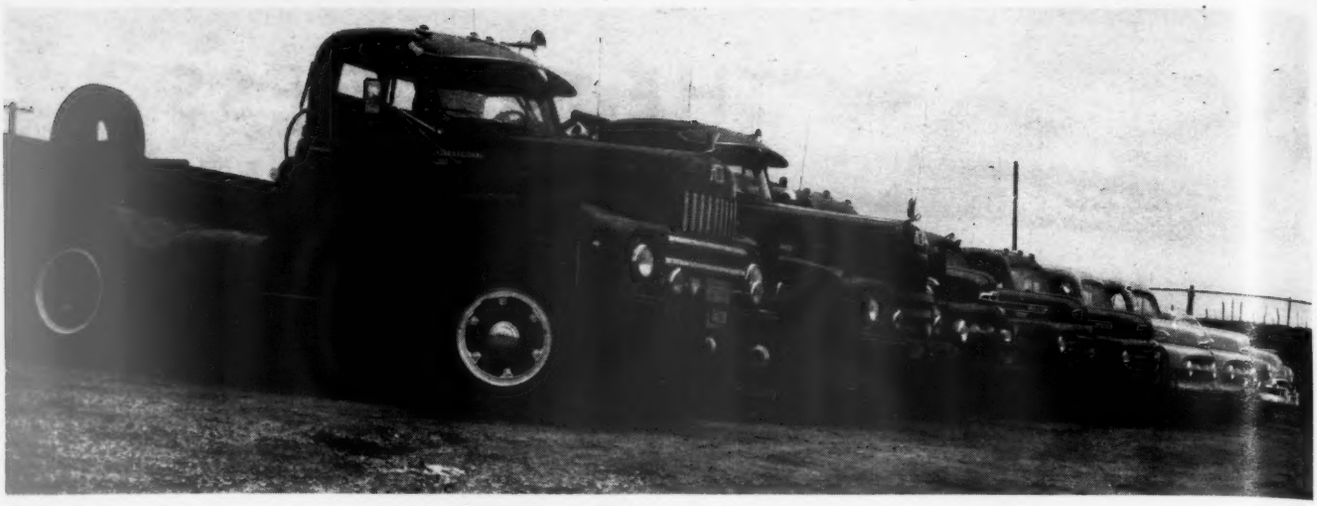


General view of typical Northern Natural fleet equipment found at a pipe line warehouse. The vehicles are lined in a row at the Lincoln, Nebraska, warehouse.

Use of Trucks in the Pipe Line Industry

Many and varied are their functions in the construction and operation of the oil and gas industry's lifelines

FRANK H. LOVE*

PART 2

TRUCKS are employed by operating companies principally as a conveyance for crews and equipment employed in repairing and maintaining lines. There is a limited amount of construction work. When the latter is of any considerable magnitude, it is contracted. Operating company trucks are used secondarily for hauling valves, pipe, engines, scrubbers, and heavy construction and maintenance equipment such as draglines, tractors, cranes, and dozers.

Trucks as used by operating companies range in size from ½-ton to 10-ton. The sizes in greatest use are those in the range of ½-ton through 3-ton.

Generally a serviceable truck can be selected from stock models, and only in a few instances is it necessary to have a unit custom built. Some companies go further than others in this respect. There are those who purchase the power unit and chassis from stock issue but require that all body fabrications be made to their specifications. In all instances there are certain adaptations that must be made to stock models. They require, variously, the addition of such special equipment as winches, oilfield bodies with ginpoles, snatch blocks, special bodies for crew trucks, backfill racks, trailer hitch, headache rack, roller tail bumper, electrical brake controls, tachometer, tarpaulin, storage space for small tools, work bench, pipe bending equipment, etc. For some operations it is necessary to equip with special tires, such as mud or snow grips. The lifetime of a tire, in maintenance service, incidentally, may be anywhere from 15,000 to 50,000 miles, depending on operating and load conditions. On the other hand, pipe line trucks apparently do not require special brake linings, the possible exception being when they are operated in considerable slush and mud or over extremely hilly terrain with heavy loads.

Such extra equipment usually is installed by company crews or by private garages to which are entrusted a part of the mechanical work.

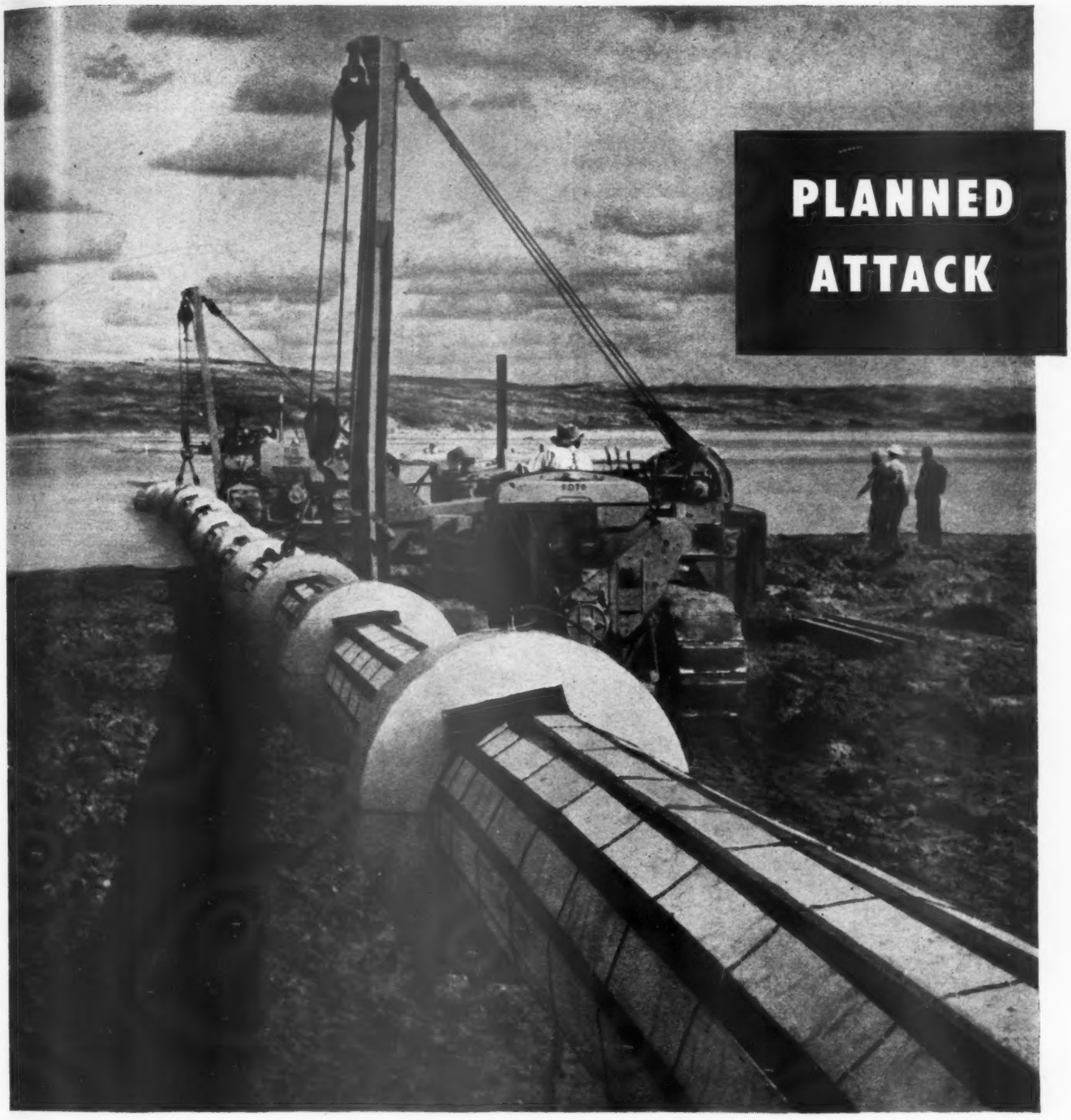
Purchasing Policy

Operating companies universally keep an open mind on the question of what brands of trucks are most suitable for pipe line work. They recognize that there are many good trucks and make their selections upon the basis of suitability for a particular job. Here per-

Portable pumping unit on truck, in use in West Texas by Service Pipe Line Company.

*Editor, Oil and Gas Pipelining.

EXCLUSIVE



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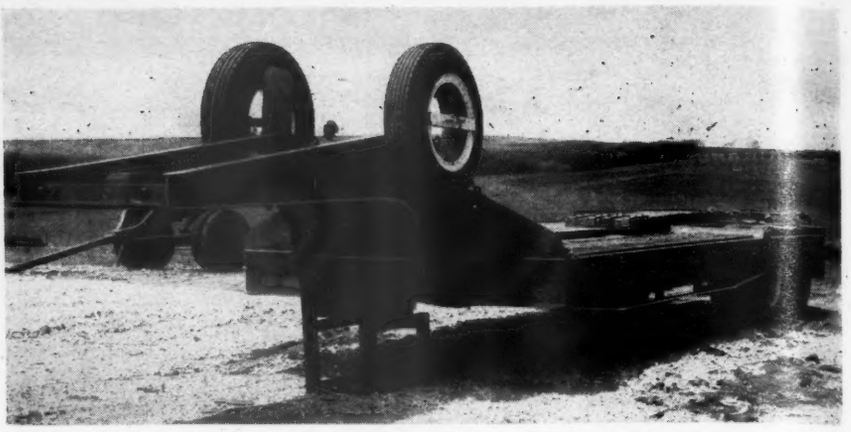
sonal opinion enters in, as foremen and superintendents are usually permitted to make recommendations to the main office. Sometimes the head of the transportation department of the company decides on the makes of trucks that will be purchased, but he works in close cooperation with the department that uses them. Other companies allow the superintendents and foremen to initiate the requisition for what units they think are advisable, with the motor transportation superintendent or equipment superintendent making recommendations. Purchases are made entirely through the main office, but this does not necessarily mean that all trucks are bought in the city where the operating company has its headquarters. Quite often they are purchased from dealers throughout the system.

Some companies flatly state that price is not a consideration in truck purchases. Most, however, admit that it is a factor, but a factor secondary to the truck's suitability for the job at hand. After the latter is determined, the aim quite naturally is to obtain the most favorable price possible. National fleet agreements are entered into for this reason, for the purchase of trucks, tires, and parts.

The serviceable lifetime of a truck varies with operating conditions and with size of the unit—whether light, medium, or heavy duty. The average retirement age of light trucks used by operating companies is 2½ to 3 years; medium trucks 3 to 4 years; and heavy trucks about 5 years. Inasmuch as operating companies use more light weight trucks by far than any other kind, the average lifetime of a pipe line truck is about 3 to 3½ years. Determination of the end of its usefulness is based on mileage, years in service, and mechanical condition. The most important of these factors, obviously, is the condition of the equipment. Retirement of a unit is initiated in the field. Usually this takes the course of the automotive supervisor



Tandem lowboy trailer capable of handling loads of 35 tons.

This 10-ton truck is in Northern Natural Gas Company's fleet. It is used to haul heavy loads short distances or may be roaded at low speeds. Here a tractor is being loaded onto a lowboy trailer attached to the truck.

View inside cab of a truck equipped with two-way radio using a hand microphone. In this instance the speaker is behind the grille. Sometimes the speaker is attached to the bottom of the dash directly next to the radio control head.

Truck equipped with a front end winch.

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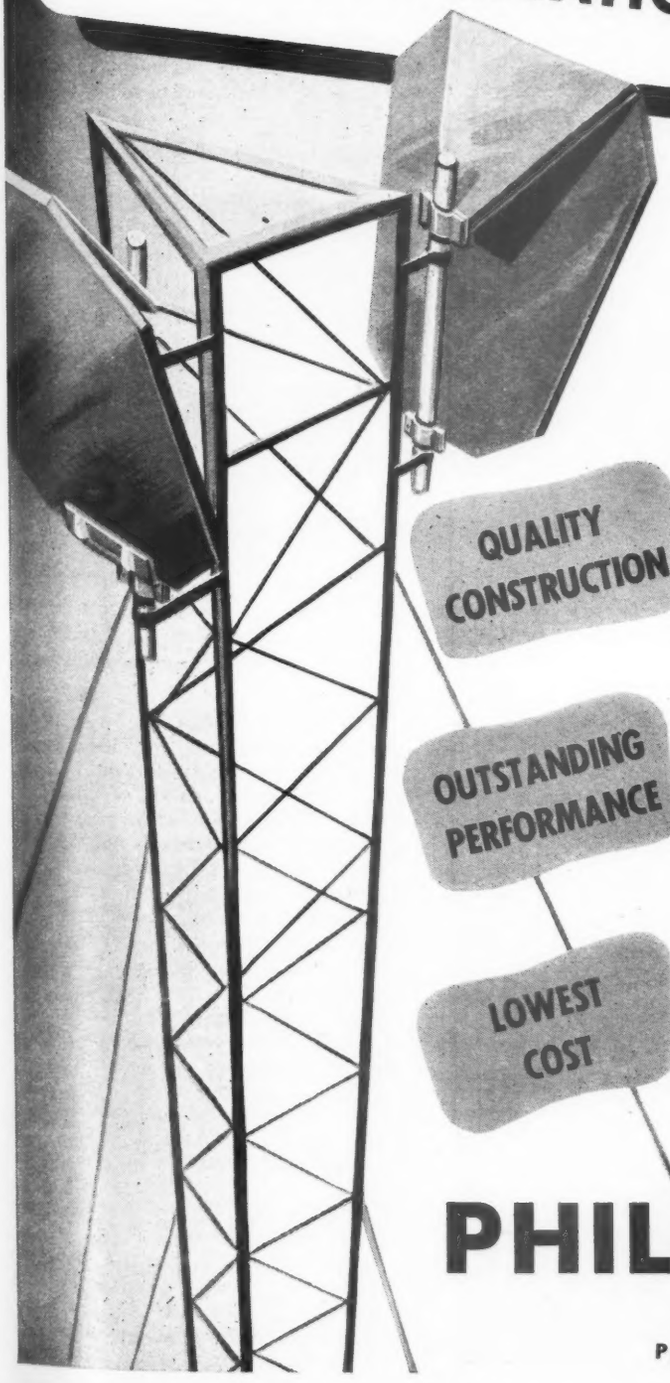

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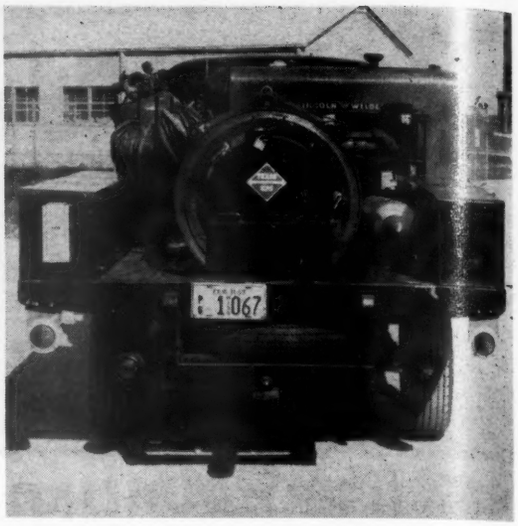
Crew truck used by Service Pipe Line Company.

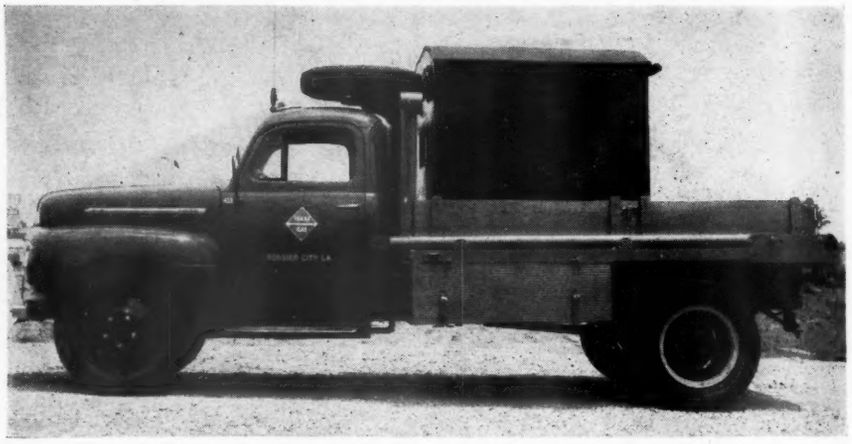


Welders' truck used by Texas Gas Transmission Corporation. This one-ton truck is equipped with a 200-amp welding machine, two-way radio, and beveling machine.

making a recommendation to the area manager who in turn obtains head office approval for replacement. When the final decision is reached the unit may be sold outright or traded in on a new unit. Both policies are followed but not always in the case of an individual company. Some companies trade only, some sell outright only, and some do whichever they believe is to their best advantage.

Operation and Maintenante

To maintain these vast fleets in perfect working order most companies have their own automotive repair shops, usually at division headquarters, but even then their own facilities are quite often inadequate properly to service such a great number of units. Independent garages are used extensively. One company, which also does its own construction work, has a mobile repair shop for each construction spread. This is mounted on a large semi-trailer and is moved from location to location as work progresses. This mobile shop supplements a centrally located repair shop.



Standard crew truck of Texas Gas Transmission Corporation, which has a special oilfield body, passenger canopy, low mount winch, grill guard, coupling for pipe trailer, and two-way radio.

A Transcontinental Gas Pipe Line Corporation maintenance crew loads small diameter pipe on a lowboy at Anderson, South Carolina.

The operation of a large truck fleet involves more details than are readily apparent. Numerous reports have to be made and records kept covering the various phases of operation. After trucks are assigned it is necessary to have a record at all times of where these trucks are, what their operating costs are, etc. Usually a company will assign its trucks by stations, district office, and division office. The number assigned to each group varies, but here is the way one representative company lists its assignments:

Station—one ½-ton pickup and one 2-ton crew truck.

District—three ½-ton pickups, one welder truck, one 2½-ton truck with lowboy and pipe trailer.

Division—two 5 to 10-ton trucks, four 2½-ton trucks, nine 2-ton trucks, ten 1-

The Hand of EXPERIENCE Guides Your Job

RCC Working with Gulf Southern on United Gas Contract

River Construction Corporation has a major share in the construction of 1,017 miles of pipe line for United Gas Pipe Line Co., which is believed to be the largest single contract ever awarded for pipe line construction. The contract is being undertaken by Gulf Southern Contractors, a joint venture under the supervision of Robert Thomas, vice president and general manager of River Construction Corporation.

The job involves laying large diameter pipe through miles of forest and swamp, with many river crossings including the Mississippi, and 28 miles out into the Gulf of Mexico.

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ROBERT THOMAS, Vice President and General Manager

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Northern Natural two and three-ton trucks of this type are used in hauling heavy equipment, cross-country loads, and pipe.

Another type of crew truck used by Service Pipe Line.

Two-wheeled trailers, like this one, are used to haul pipe.

ton trucks, and twelve ½-ton trucks. The listing under "division," it is pointed out, includes trucks listed under "station" and "district."

Another company assigns 19 ½-ton trucks to its stations; four ¾-ton and three 2-ton winch trucks to its districts, and one 7½-ton, one 3 or 4-ton, and one ¾-ton truck to its divisions.

After these assignments are made a periodic report is required showing the location of the equipment. This usually is a monthly report. Another type of record required is an analysis report that itemizes costs for each truck, including fixed costs, cost per mile of operation, depreciation, etc. In addition, records are kept on mileage, repairs, and inspection.

Operational costs may be paid for on expense account, on regular purchase order, or emergency purchase order.

Improvements Suggested

As was true in the case of contractors, those in charge of trucks for operating companies have some definite ideas regarding how equipment might be improved for pipe line service. Better frame reinforcement is one. They believe more thought should be given to the location of cross members, etc., to facilitate the mounting of winches and special equipment, and that the front end of the frame should be designed in a manner to make the installation of grill guards and front tow hooks more easily. Cabs should be designed to make it easier for the driver to operate winches and other special equipment. Service brake hand controllers should be installed to provide brakes on all wheels, which would free the truck driver's right foot for use on the accelerator.

Existing state laws present formidable problems to pipe line company and contractors alike. Perhaps the most objectionable one to pipe liners is the overall length limit on highways of 45 to 50 ft. Most of the pipe used in pipe lines today is shipped in double random lengths, which run up to 50 or 51 ft. This necessitates overlength permits in virtually all states. There are a few exceptions. The state of Mississippi, for example, has a special provision in its law that permits the transportation of overlength pipe and poles provided they are properly loaded and flagged.

Trouble also is encountered in complying with the laws regulating width and height of vehicles. Most tractors and draglines used in pipe line work are approximately 10 ft wide, and when loaded in a lowboy trailer are usually 13 ft 6 in. to 14 ft high. It is, therefore, necessary to procure an over-dimensional permit in such cases. Considerable time is spent in obtaining these permits, and the cost of telephone calls, telegrams, etc., as well as the cost of the permit itself, amounts to a considerable sum. Then there is usually an unwarranted delay in getting delivery on the permits, which results in lost time for the truck driver and machine operator and helpers, in addition to the loss of production from the machine. * *

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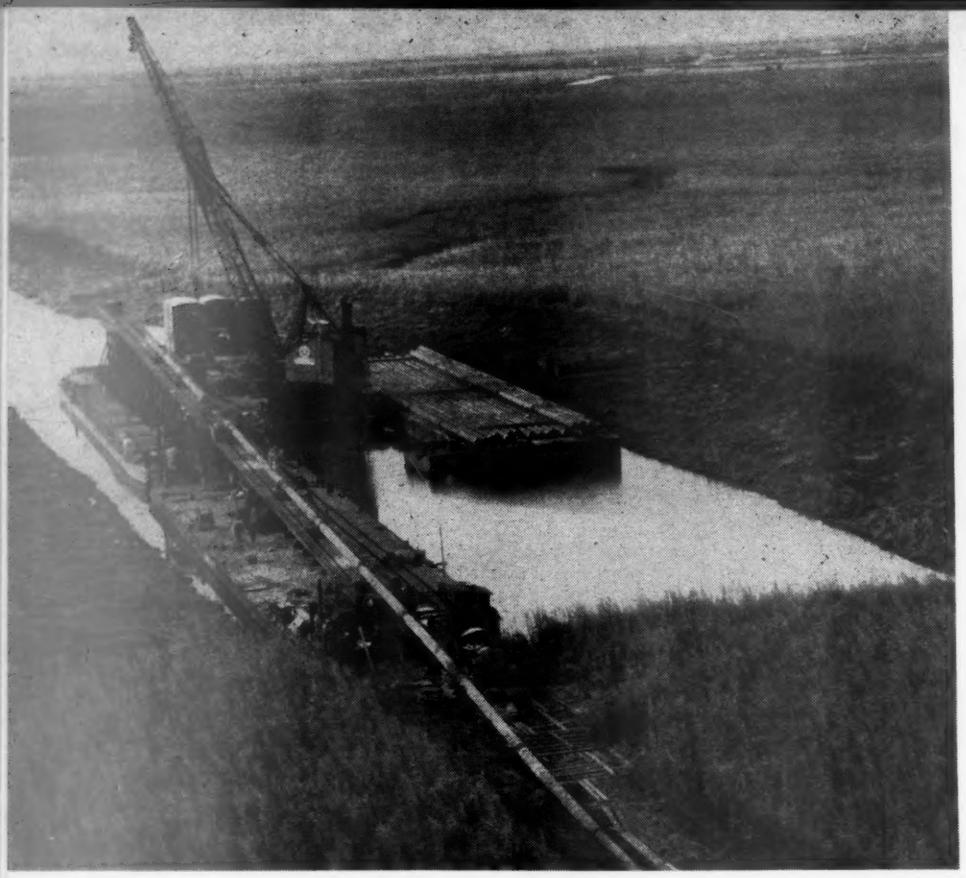

Aerial view of the giant ramp at the shore line.

A PIPE LINE GOES TO SEA

United Gas Pipe Line Company makes construction history with its 25½-mile, large-diameter line from Louisiana Coast into the Gulf of Mexico

ONE of the greatest construction feats in the history of pipelining has been consummated along the coast of Louisiana. United Gas Pipe Line Company completed during October the first large-diameter pipe line ever laid into the Gulf of Mexico. Never before has the pipelining industry witnessed anything to compare with the long string of ponderous, concrete-coated 14 and 20-in. pipe reaching seaward to bring tideland gas from the Eugene Island area into United's system.

The big sea-going pipe line—25½ miles long—is part of United's program under construction in Texas, Louisiana, and Mississippi, to expand and reinforce the company's present transmission facilities. The overall program is designed to provide an increase in system delivery capacity of more than a billion cubic feet a day, and much of the additional gas needed will be collected at sea and transported to shore by the new submarine line.

The 20-in. line entends 15 miles to the site of Pure Oil Company's Block 32 drilling platform. From Block 32 to Magnolia Petroleum Company's Block 51 drilling platform 14-in. pipe was laid, a distance of 10½ miles.

The two sections were laid by different contracting firms, the 20-in. by Gulf Southern Contractors, and the 14-in. by Brown and Root, Inc.

Construction of this 25½ miles of gas line is without parallel in the annals of pipelining. Its very nature has challenged the skill and ingenuity of men who have planned and executed some of the toughest pipelining on record. Just as construction forces of United pioneered exactly 10 years ago in laying more than 25 miles of pipe line across Lake Pontchartrain on the Lir-

Concrete platform, left, erected 15 miles offshore to serve as terminus for 20-in. line and tie-in point with 14-in. At right is Pure's Block 32 drilling platform.

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United's 20-in. pipe line, supported by pontoons, moves seaward toward the Block 32 platform approximately 15 miles from the construction ramp near Pt. Chevreuil.

Five-joint, 200-ft sections were handled at a time from the ramp.

ette-to-Mobile line, so they pioneered in this instance in building the big submarine line into the Gulf. In addition to being the first large diameter carrier laid into the Gulf of Mexico, it is the longest line of any size ever constructed offshore.

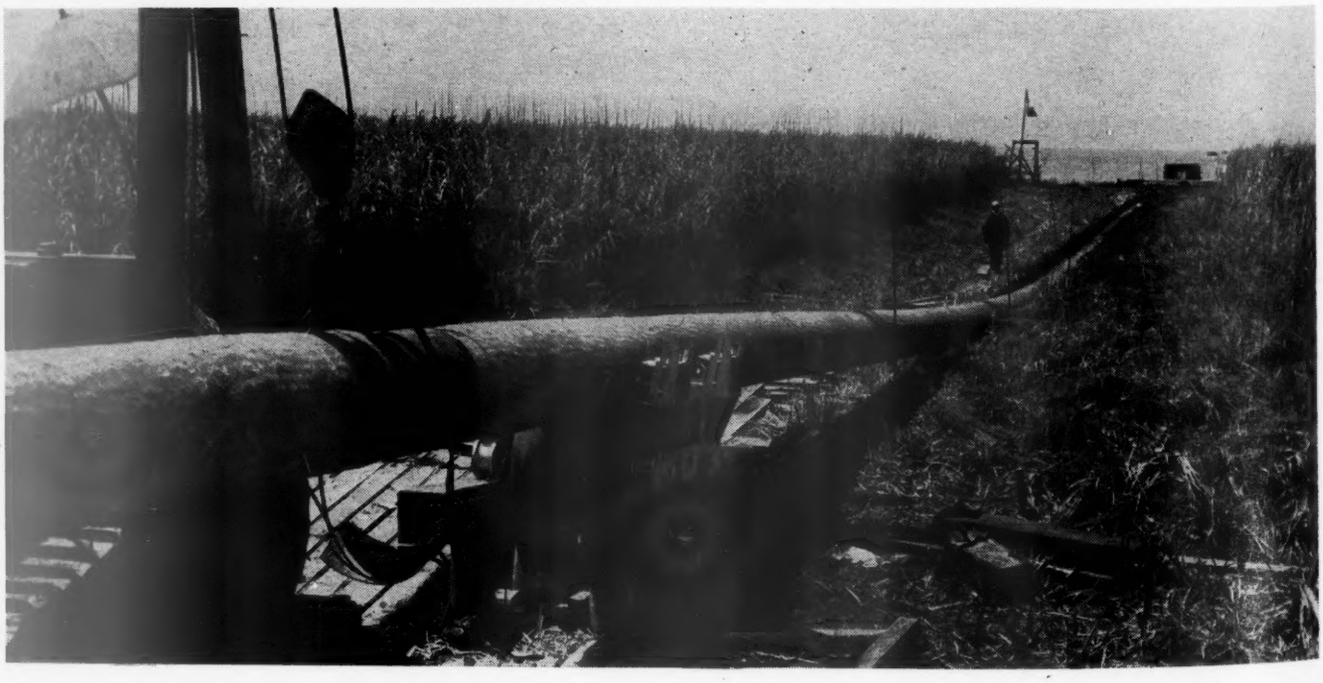
More than three years of planning and months of intensive preparations were required before the first section of 20-in. pipe went down the ramp early in July. As part of the preparation every foot of the route between the shore line and the drilling platforms was covered in an exhaustive oceanographic research program to give its planners intimate knowledge of the shallow gulf water and its characteristics. Waves, currents, water bottoms, shell reefs, and marine organisms had to be studied and understood before the project could be undertaken.

Pipe going into the 25-mile line is some of the strongest and heaviest ever used. The 20-in. pipe has a ½-in. wall thickness with an additional ¼-in. steel plate wrapped and welded around it. On top of that was a ⅝-in. Somastic coating for protection against bacteria and various chemical conditions that exist at the bottom of the Gulf, and a full inch of reinforced concrete for added weight. When ready for laying the pipe weighed 260 lb per ft. The 14-in. pipe also has a ½-in. wall thickness and to it was applied the same amount of Somastic and concrete.

For several months much of South Louisiana teemed with pipe line activity because of the several phases of United's expansion program in the coastal area. Pipeliners, right-of-way buyers, survey parties, etc., were literally swarming over the entire area; but while it was in progress the center of attention was focused squarely on the offshore job. In the words of one veteran pipeliner, it was the "big show".

Assembled at the shore line and along the route to the two drilling platforms was probably the greatest concentration of marine construction equipment ever brought together for a pipe line job. Like a task force, it included derrick barges, laying barges, winch barges, tugboats, speedboats, crewboats, and airplanes.

Looking seaward as a section of 20-in. pipe is being pulled into the Gulf. Pontoons supporting pipe can be seen in background.



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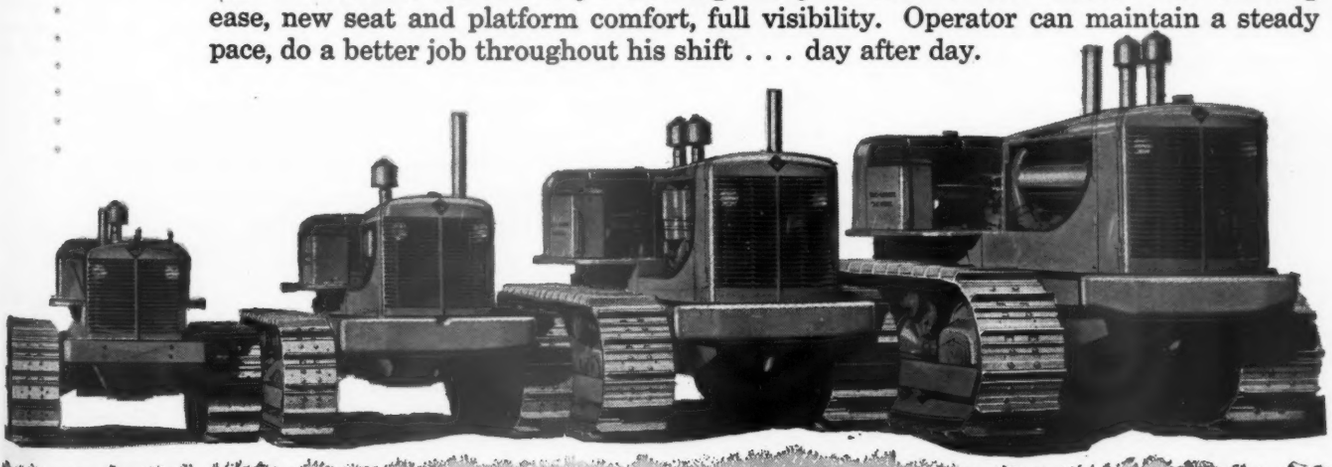

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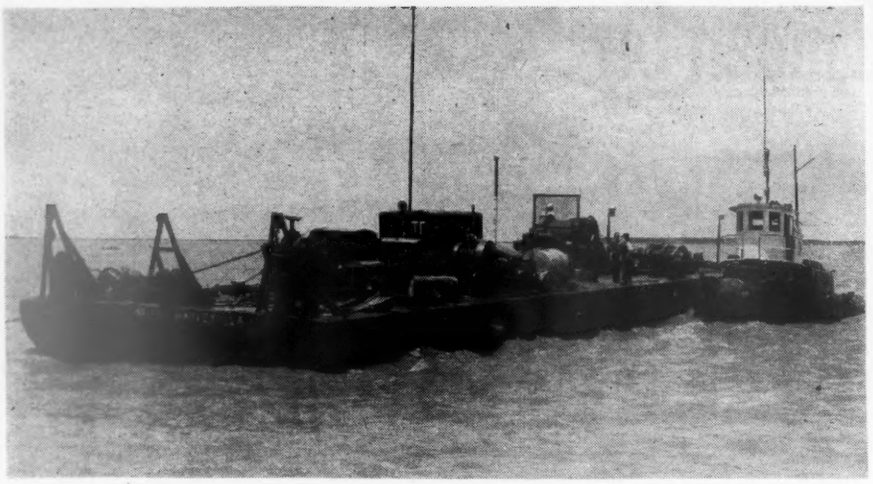

Winch barge at sea on head end of the string of pipe. Each time a 200-ft section was welded on at the ramp the winch pulled the entire string ahead 200 ft.

Even at the shoreline where the 20-in. was put seaward, everything was marine because the coastal prairie that borders the gulf for miles inland is nothing but spongy marshland that barely supports the weight of a man. It is a country of bayous and canals and "pirogue runs", where transportation is either by water or air.

The line enters Atchafalaya Bay at a spot near Point Chevreuil, some 25 marshland miles southwest of Morgan City. From there its route is due south 15 miles to the site of Pure's Block 32 discovery. Water depth along this section varies from as shallow as two ft to a maximum of approximately 12 ft at the offshore platform, and shell reefs had to be dredged through at several points to enable the barges and other marine construction equipment to navigate.

From Block 32 the 14-in. line extends diagonally in a southwest direction toward Magnolia's discovery in Block 51, 10½ miles away.

The water is deeper along this section, ranging from 12 ft to a maximum of approximately 20 ft.

The 20-in. pipe that went into the 15-mile section to Block 32 was welded into a 5-joint, 200-ft section and coated at a central yard on Bayou Boeuf a few miles from Morgan City. From there it was moved by barge through the maze of canals and bayous to the ramp location at the shore line.

The 14-in. pipe for the line between Blocks 32 and 51 was coated, and a substantial portion double jointed at another yard at Harvey, Louisiana, and then barged to the area where it was laid.

Throughout July and August field forces of Gulf Southern Contractors, an allied construction team assembled especially for the offshore job, battled heat by day and mosquitoes by night in an "around the clock" operation at the shore line ramp. It was from this 670-ft ramp that the 20-in. pipe was welded together and pulled into the Gulf, section by section.

By mid-August, Brown and Root forces were also on 24-hr schedule to take advantage of the calm sea prevailing between Blocks 32 and 51, where the 14-in. was being "stove-piped" from a converted naval vessel used as a pipe laying barge.

With both operations underway simultaneously, it presented a spectacular display of pipelining.

The greatest assemblage of equipment and manpower was at the shore line, where activity centered around the big barge-mounted pipe ramp, which sloped down almost to the water's edge, and measuring 670 ft from end to end. Anchored alongside was a 100-ton derrick barge used to handle the 200-ft sections of concrete-coated 20-in. pipe, which weighed 52,800 lb each.

Section by section the pipe was lifted onto the ramp, welded and pulled seaward. Each time a section was ready, the winch barge at sea on the head end of the string of pipe was notified by

Pipe sections were welded together from a platform midway up the ramp.

Looking inland from bottom to top of the long ramp.

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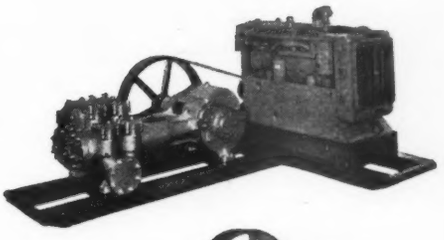

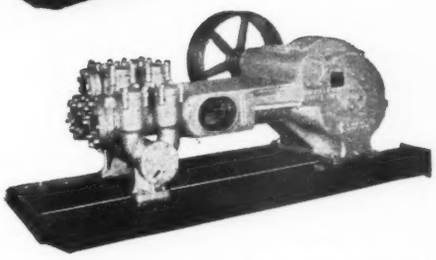

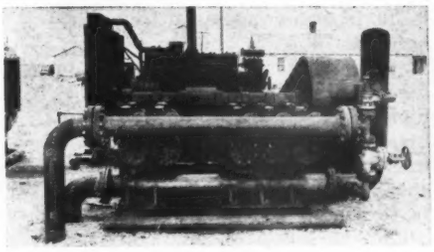

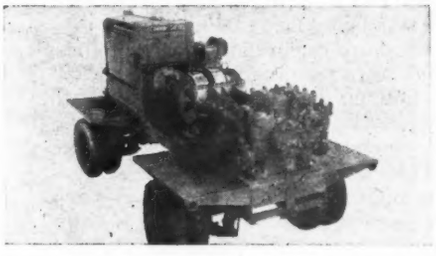

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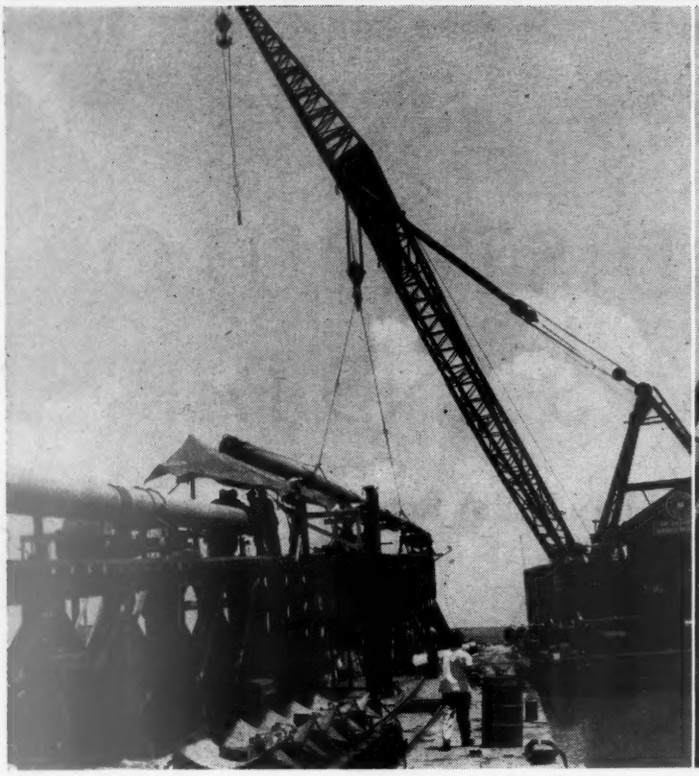
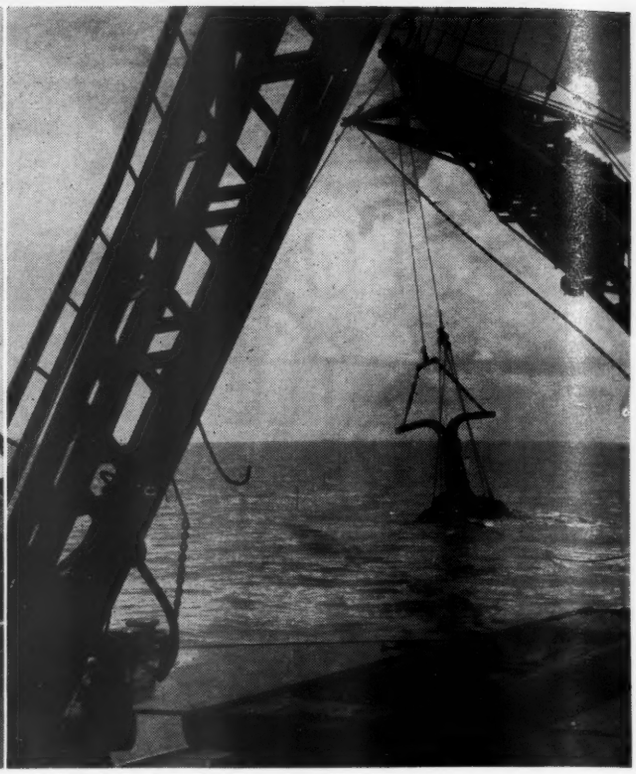


Hoisting a 200-ft section of 20-in. pipe up on the ramp.



Shell reefs had to be dredged through in several areas between the shore line and Block 32. Notice staked route in the background.

radio, and its big winch, capable of pulling 155,000 lb at a time, went into action. It moved the long string of pipe ahead 200 ft and then stopped to wait for the next section to be welded on back at the ramp. Actual pulling time for each 200-ft section averaged from 12 to 14 minutes.

As each section reached the bottom of the ramp, another was picked up by the derrick barge, lifted onto the ramp, and made ready for the next pull. The entire 15 miles was put together in this manner.

On the ramp, the pipe was strapped in saddles on specially made dolly cars, which traveled along narrow-gage steel tracks laid from top to bottom. When a pull was being made the section of pipe eased down the ramp on the dollies, which were removed when they reached the bottom. This method was used to prevent damage to the pipe's Somastic and concrete coating.

Welding was done on a special platform built midway up the ramp. Each new section of pipe was eased down against the one ahead, lined up, and welded. Approximately 9 lb of metal and two hours welding time were required for each joint because of the ¾-in. thickness of the pipe and its large diameter. Once the weld was made and tested by X-ray, the joint was coated with Somastic and the section was ready to be pulled.

Actually, the line was pulled seaward in several long sections. Each time the contractor completed a string of from 8000 to 10,000 ft of pipe, the winch barge would pull that much out to the platform, or to the point where the last string stopped.

The barge equipped with anchors and steel "legs", which were dropped to the bottom to hold it in place for each pull, was moved about by tugboat. The powerful winch had cable to pull 600 ft at a time before the barge was moved ahead.

Pontoons were attached to the string of 20-in. approximately every 500 ft to buoy the line so it could be pulled. Without them the heavy pipe would have sunk into the muck and ooze overlaying the bottom of the Gulf.

When completed and tied-in, a ditch was dragged for the entire line and it was lowered to the specified depth. The U. S. Corps of Engineers requires that the pipe be at least 3 ft under the bottom of the gulf where the water is as shallow as 12 ft, but United Gas engineers specified a 5-ft minimum cover for the entire 15 miles of 20-in. to make certain that no storm, even hurricane force, could scour off the backfill and expose the line to wave action.

One month after the first section of 20-in. pipe was pulled seaward, Brown and Root forces, working 15 miles out at sea, let down the first double-jointed section of 14-in. on the line extending to Block 32. Aided by a smooth sea, the construction crews made good progress from the beginning.

United erected a concrete platform about 1000 ft west of Pure's drilling installation in Block 32. Standing 40 ft above the water and resting on eight concrete pilings, which were sunk deep beneath the floor of the gulf, it serves as a terminus of the 20-in. line and the tie-in point with the 14-in. that extends on to the Magnolia platform. Two short 14-in. lines connect United's platform with that of Pure's and thus gas from both Block 32 and 51 wells will enter the 20-in. line at the concrete platform to be transported to land by the 15-mile undersea carrier.

From the shore line the 20-in. extends inland through canal and marsh country until it reaches a point called Burns on Bayou Sale, approximately 3 miles from where it leaves the gulf. There the pipe size increases to 26-in. and the line heads northward toward Bayou Sale Junction, 13½ miles away, where the 30-in. begins. * * *

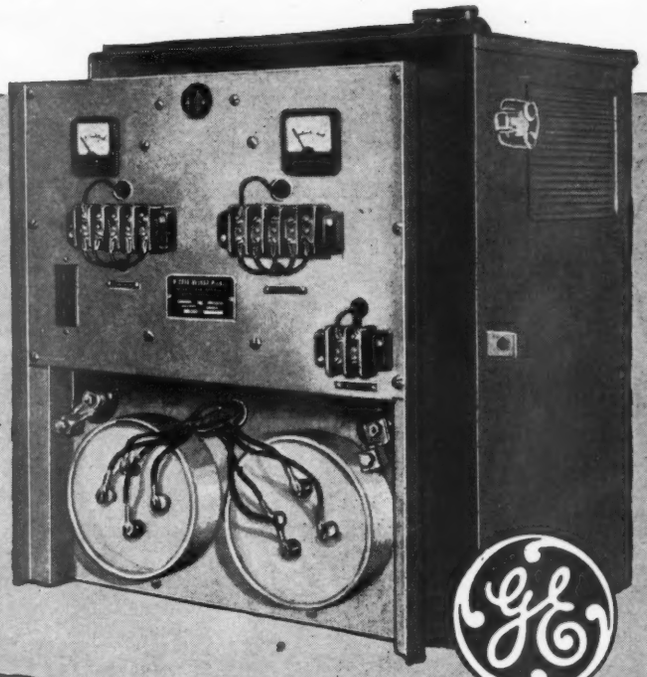
Canadian Oil to U. S. Plant

Cleveland Tankers, Inc., delivered the first cargo of Canadian crude oil, shipped by lake tanker, to an American refinery. The S. S. Comet loaded approximately 32,000 bbl of 33 gravity Canadian Red Water crude oil at the eastern terminus of the Interprovincial Pipe Line Company and delivered it to the Old Dutch Refining Company at Muskegon, Michigan. The ship was under the command of Captain Robert Robbins and is owned and operated by Cleveland Tankers, Inc.

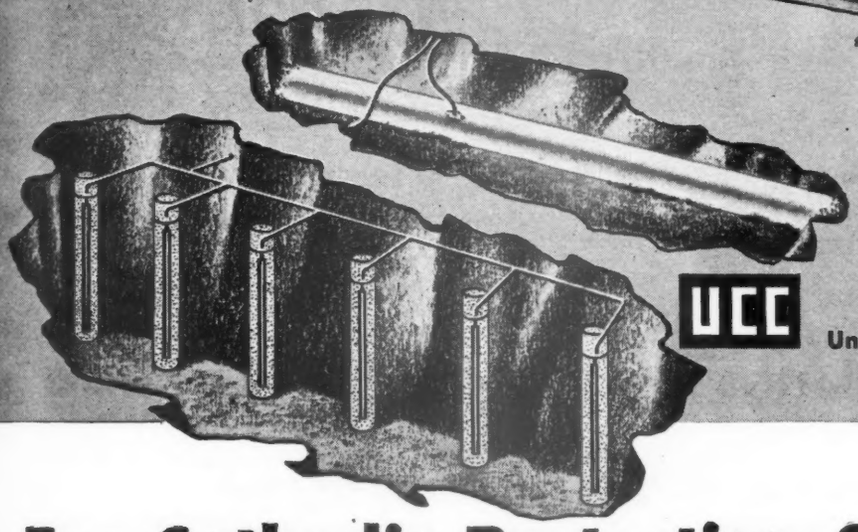
The 1180-mile pipe line from Edmonton, Alberta to Superior, Wisconsin has been carrying crude oil for lake shipment to Canadian oil refineries but this is the first movement of Canadian crude to an American refinery by water.

The Superior end of the pipe line is operated by Lakehead Pipe Line Co.

SELENIUM RECTIFIERS and ELECTRODES



GENERAL ELECTRIC



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Hermetically-sealed General Electric selenium rectifiers are available in a complete range of types to meet requirements of any specific application.

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Three grades of "National" ground electrodes are available to meet the demands of almost every cathodic protection application:

Graphite electrodes are especially resistant to electrochemical oxidation.

Na Graphite electrodes, impregnated to eliminate porosity, are recommended for salt environments or salt water applications.

Carbon electrodes have been developed for application when bromides or fluorides are present. Electrodes are available in complete range of sizes and shapes.

HARCO CORPORATION offers a complete Engineering and Contracting Service for the installation of Cathodic Protection Systems. Because the problems of each installation vary according to soil, seasonal and atmospheric conditions, Cathodic Protection Systems should be job-engineered for maximum effectiveness against corrosion.

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Write today for catalogs describing rectifiers, electrodes and Harco service.

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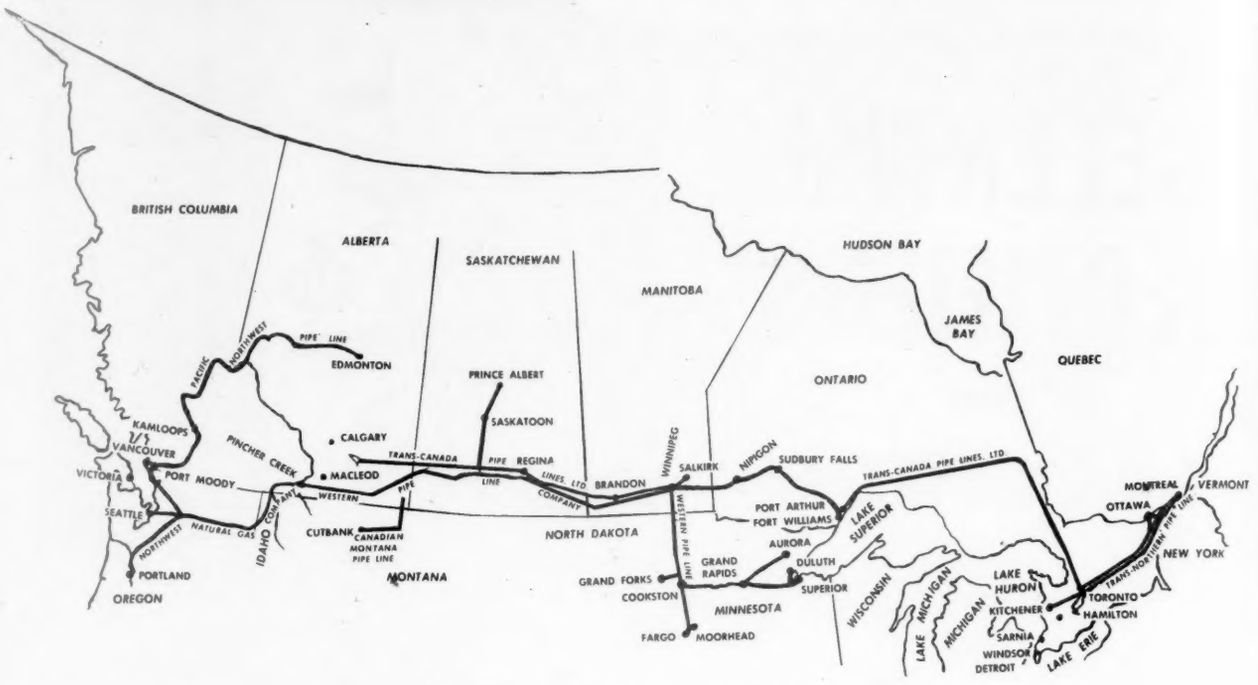


This map shows routes of pipe lines proposed for Canada.

Many Pipe Lines Proposed for Canada

DECISION MAY BE REACHED BEFORE END OF YEAR ON WHICH LINES WILL BE GRANTED PERMITS

HARRY CHAPIN PLUMMER

UPON decisions reached by the Alberta Petroleum and Natural Gas Conservation Board, at hearings that began at Calgary late in October may depend the early start of a network of natural gas and oil pipe lines over Canadian terrain from the Pacific Coast to Montreal. The Board of Transport Commissioners postponed its hearings at Ottawa from September 22 last for the following six months, to April 7, 1952, but indicated that should a favorable decision on the granting of permits be reached following the Calgary hearing, hope might be entertained for the fixing of an Ottawa date well in advance of April next; even, possibly, before the end of the current year. Some applications had been pending before the Transport Board for more than a year at the time of the postponed September hearings.

Not only will the revenues of Alberta Province be stepped up by the granting of applications filed at Calgary and Ottawa, but the national economy is due to be most favorably affected by affirmative findings of the two bodies. Among the newer projects awaiting action by the Ottawa commissioners are the 2240-mile long Trans-Canada Pipe Line, Ltd., to extend from Princess, Alberta, in the Calgary area, east to Montreal, with spurs from Toronto west to Kitchener and Stratford, and north from Morrisburg, Ontario, to Ottawa, and the Trans-Northern Pipe Line, a 444-mile oil line from Montreal to Toronto, Hamilton, and Kitchener and branch line from Prescott, already a Canal-Great Lakes tanker delivery center, to Ottawa.

A third major operation planned is that by Western Pipe Lines, totaling 1600 miles, from the Pincher Creek field across the western Canadian prairies, via Winnipeg, to and across the Minnesota boundary to Duluth and Superior in the United States. To be underwritten by the financial house of Osler, Hammond and Nanton, Ltd., of Winnipeg. the line is designed to feed natural gas to the Mesabi ore range in the processing of taconite ore.

EXCLUSIVE

Trans-Canada

Construction details of the three longest lines of the proposed Canadian network have just been disclosed to *The Petroleum Engineer*. Completion of the Trans-Canada project would make it among the longest pipe lines in the world. The aggregate distance of Trans-Canada is divided as follows:

Main Line (Princess, Alberta, to Brooklin, Ontario) 30-in.—1803 miles.

Lateral (Brooklin to Montreal) 24-in. —295 miles.

Lateral (Brooklin to Stratford) 18-in. —110 miles.

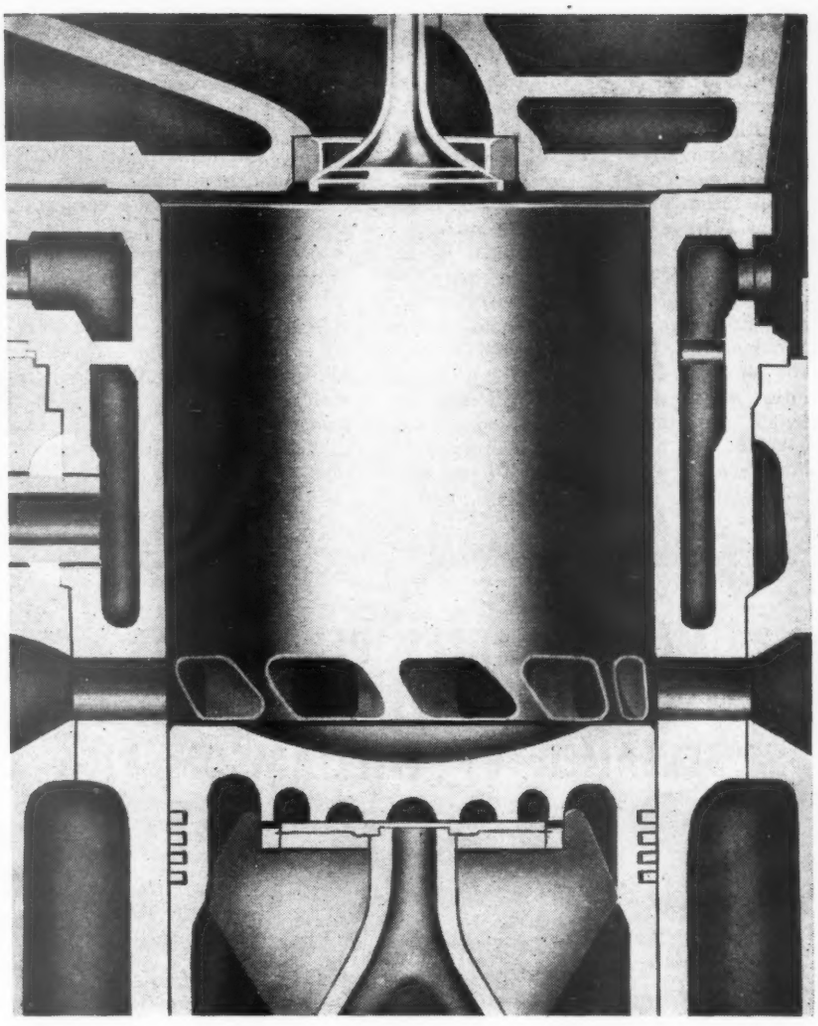
Lateral (Morrisburg to Ottawa) 14-in.—39 miles.

Gathering system (Alberta) 8-24-in. —747 miles.

The main line will be 30-in. OD by

IT'S THE

Biggest News in Gas-Engine Compressors



The *vital power center*

that cuts down-time and increases efficiency in many gas and petroleum-processing services

For the first time, a vastly superior type of scavenging has been applied to compressor engines.

Worthington's timed scavenging system, built into the uniflo UTC-16, gives advantages far beyond any previous method.

A Thoroughgoing "Clean Sweep"

Here are some of the features of this new system concentrated in the "vital power center" illustrated above:

Complete removal of exhaust gas . . . more thorough charging with gas and air . . . positive timing for optimum combustion . . . effective supercharging . . . low operating temperature preventing carbonization . . . uniform cylinder temperature resulting in equal wall stress eliminating harmful stresses.

Many Uses . . . Many Sizes

While designed primarily as a pipeline gas-engine compressor, the UTC-16 is suitable for many other services, including: pressure maintenance on oil wells . . . in natural gasoline plants . . . in oil refineries, for solvent extraction, vapor recovery, recycling and stabilization of gases . . . in petrochemical processing of products made from natural gas under pressure . . . in many refrigeration applications.

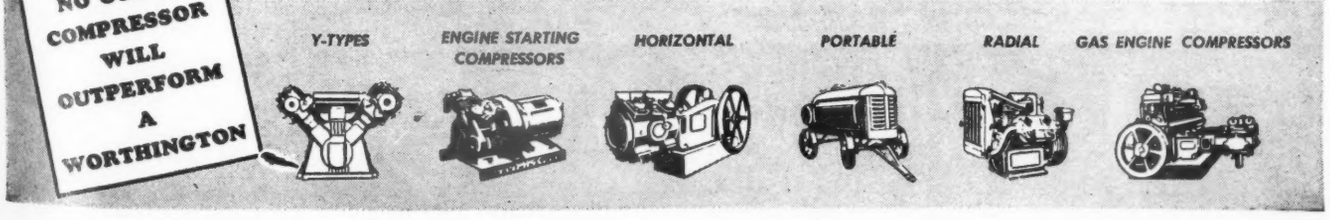
The Uniflo UTC-16 is built in sizes ranging from 800 to 2000 hp. For further proof that *there's more worth in Worthington*, contact our nearest Branch Office, or write the Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.

WORTHINGTON

ENGINE COMPRESSORS

EK.1.2

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON



5/16-in., weighing 98.93 lb per ft, consisting of X52 steel. Normally the pipe will be prepared as follows: Primer, hot coat, glass wrap, shield wrap.

Initially there will be 13 main line stations having a total of 94, 160 installed horsepower.

Operation of the Trans-Canada Pipe Line at its estimated requirement of 365,000,000 cu ft a day would, in itself, provide 50 per cent of Canada's requirements of sulfur, 150,000 gal of gasoline a month, and bring an income to the Province of Alberta of about $20,000,000 per year. Inclusive of the gathering lines in Alberta, the line will total in length 2983 miles. It is estimated that 639,446 tons of steel will be required, but because of the contribution natural gas could make to the defense preparedness program and to Canadian industrial expansion, it is realized that, short of total war, the necessary steel could be forthcoming. Two years are cited as the construction time following final official approval.

Stemming from the corporate owner, the Canadian Delhi Oil, Ltd., Calgary, Alberta, affiliate of the Delhi Oil Corporation, of Dallas, Texas, of which C. W. Murchison is president, the Trans-Canada system, as now planned, provides for the complete construction of all facilities for gathering natural gas within the Province of Alberta and transporting it to existing markets in the provinces of Saskatchewan, Manitoba, Ontario, and Quebec. The point of origin is Princess, Alberta, in the Calgary area of southern Alberta.

The preliminary engineering, routing and cost estimates are being done by the Oklahoma Contracting Company and Pipe Line Engineering Company, both of Dallas. Study of the natural gas reserves of the Province of Alberta is being conducted by DeGolyer and McNaughton, Dallas. Market analysis for the project is being made by the H. K. Ferguson Company, of Cleveland, Ohio. Orders for the materials and equipment and construction contracts have not as yet been let.

The route to be followed by Trans-Canada would, generally speaking, parallel that of the Canadian Pacific Railway as far east as Winnipeg. A decision has not thus far been reached of the exact route to be followed between the Manitoba-Ontario border and Nipigon, but months of careful study from the air and on the ground have shown that, despite the difficult terrain, the line can be constructed through that area at an economical figure. From Sudbury the line would proceed southward to Toronto and thence along the northern shore of Lake Ontario and the St. Lawrence River to Montreal. Laterals off the main line would service southwestern Ontario and the Ottawa district.

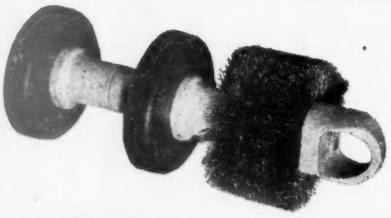
An extensive market survey has proved the economic soundness of the project. Industrial and commercial consumers in Ontario and Quebec, who, in recent winters, have been forced to curtail production or servicing activities because of power shortages, are most interested in the possibility of utilizing Alberta gas. In Ontario, where industrial expansion threatens another power dearth and where more and more electrical energy is being generated by costly steam plants, efficient, care-resistant natural gas would solve many problems. Officials of Trans-Canada are confident that natural gas can be retailed in Montreal at a price that will compare favorably with that of coal. Trans-Canada's function, they aver, will be that of conveyor and wholesaler only and the gas will be sold to utilities in the various municipalities along the line and those sufficiently near the proposed route to make the operation of lateral lines an economical and profitable undertaking.

Of the six applicants for gas export licenses brought before the Alberta board—and at least one other company has indicated it will apply—Trans-Canada is the only one planning a fully Canadian route.

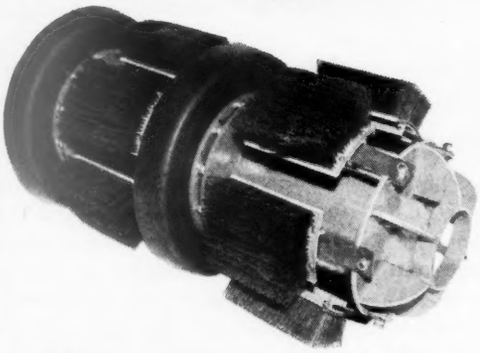
Apart from the six natural gas export license applicants, there are two companies in the crude oil field seeking to build pipe lines from Alberta to Vancouver: The Independent Pipe Line Corporation, of Calgary, and the Trans-Mountain Oil Pipe Line Company. R. A. Brown, Jr., of Calgary, is president of Independent, which, it is understood, has the backing of British-American Oil Company, Ltd. Equal stockholders in the Trans-Mountain Oil project are Imperial Oil Limited, Socony-Vacuum

THE PIG WITH THE POKE — CLEANS PIPE LINES

MORE BARRELS PER DOLLAR . . .
THROUGH OIL PIPE LINES
CLEANED BY WILLIAMSON PIGS



Type JR Pig 2" to 5" sizes. Economical and Rugged.

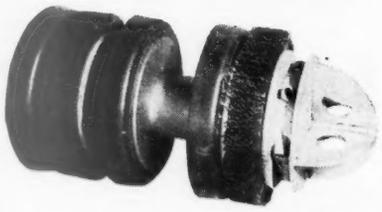


Type GP-4 Pig 16" to 30" sizes.

Similar design for 10" to 14" sizes.

Brushes expanded by arched springs.

Brush and cup service life up to 1,000 miles.



Type RC-50 Pig 8" to 14" sizes.

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Jet-rotation feature distributes wear of brushes and cups.

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Here's 1 Controller that holds 2 related variables within set limits

The NEW FOXBORO M-40 AUTO-SELECTOR

This Unique Controller operates from two related measurements, automatically transferring control from one to another as required to prevent either one from exceeding its set limit. As in the case diagramed at right, when supply is greater than demand, control is maintained on the demand side (discharge) . . . but when demand exceeds supply control is maintained on the supply side (suction).

The M-40 Auto-Selector has two measuring elements and control mechanisms — also a combined air relay. It actually does the work of two instruments . . . with one or the other variable under control at all times. The transfer of control from one variable to the other is smooth, instantaneous, and with no upset. Any type of control action may be used. Any combination of related variables may be controlled - pressure and flow; temperature and level; two flows; two pressures; etc.

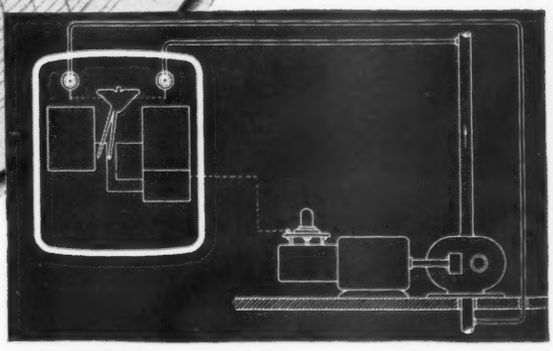

DIAGRAM *with accompanying chart above illustrates one of many applications. Pump drive is controlled to keep suction pressure from dropping below a set minimum, and discharge pressure from exceeding a set maximum. The instrument automatically controls from either variable as changing conditions require. On the chart, the outer record is for discharge pressure, the inner, for suction pressure.*

Write for details. The Foxboro Company, 13011 Neponset Ave., Foxboro, Mass., U. S. A.

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WITH TAPECOAT*

—the Coal Tar Coating in Handy Tape Form

—Sized to the job

24″ WIDTH

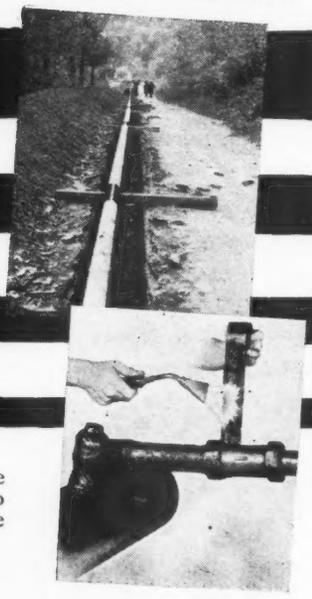
TAPECOAT — the economical coal tar coating for "cigarette-wrapping" mechanical couplings, large diameter pipe, joints, bends and drips.

18″ WIDTH

TAPECOAT—the practical coal tar protection for "cigarette-wrapping" of large couplings, pipe bends, and joints on large diameter pipe.

6, 4, 3, and 2″ WIDTHS

TAPECOAT — the distinctive, time-tested coal tar tape for spiral-wrapping welded field joints, service connections, pipe under streets and sidewalks, and pipe through building walls.



For more than 10 years, Tapecoat engineers have specialized in pipe joint protection. Call on them to help you meet your individual requirements. Write today for complete details.

The* TAPECOAT *Company

Originators of the Coal Tar Tape for Pipe Joint Protection

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1533 LYONS STREET • EVANSTON, ILLINOIS

Oil Company, Gulf Oil Corporation, and the Bechtel interest (one of the world's largest pipe line builders).

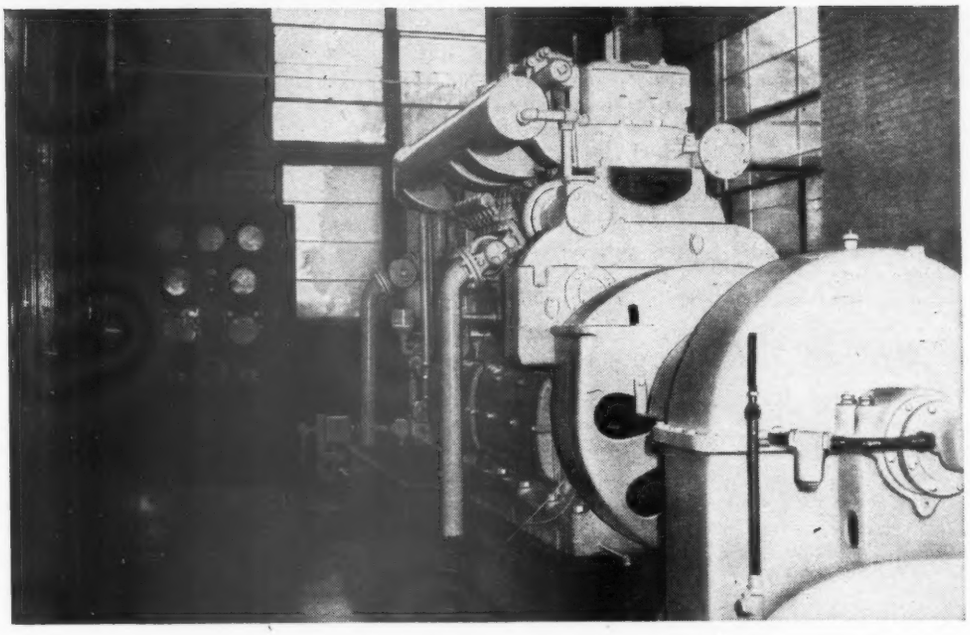
Another natural gas applicant is Prairie Transmission Lines, Ltd., the name of which has now been changed to Pacific Northwest Pipe Line Corporation. It seeks 100,000,000 cu ft per day or 36.5 billion cu ft per year, to supply the British Columbia market. The company admits that is a great deal more than the British Columbia market can absorb initially, but it asserts demand may eventually build up to that figure. Any gas over and above the 100,000,000 cu ft per day, the company further states, will augment supply for its proposed line from Texas to the Pacific Northwest states. In the event Alberta should be able to supply 250,000,000 cu ft per day, it would pipe gas from the the United States to eastern Canada on an exchange basis. The gas would be taken from the Pincher Creek field through Crow's Nest pass, to connect up with the company's U. S. line at the Idaho-British Columbia border. The 100,000,000 cu ft it would pipe from Alberta would be allotted to the potential requirements of the market areas to be served in British Columbia, which include New Westminster, Vancouver, Victoria and Trail.

Three of Canada's oldest established oil and refining corporations—McColl-Frontenac, Shell of Canada, and British-American—are jointly participating in the development of the Trans-Northern Pipe Line Company's project. This line will transport petroleum products from Montreal to Toronto and Hamilton, a distance of 400 miles, by 10-in. line, and to Ottawa by 6-in. branch line from a junction with the main line near Cornwall, Ontario, a distance of 44 miles. The main line, to be buried to a depth of 24 to 30 in., will traverse the north shore of the St. Lawrence River and Lake Ontario, having terminals at Cornwall, Prescott, Brockville, Kingston, Belleville, Port Hope, Toronto, and Hamilton. Sites for four pumping stations have not yet been selected.

The initial design capacity of the system is to be 40,000 bbl a day. This can be increased to 60,000 bbl a day by the addition of four intermediate pumping stations.

Finished products from the three participating companies' refineries at Montreal East will form the bulk of oil moved over the system, thus freeing the industry from delivery limitations imposed by the five to six months' cessation in winter of tanker traffic over virtually the same route by the canalized St. Lawrence and the Lake.

While there will be marked savings in overhead costs by the lessened necessity for tank storage, A. N. Horne, president of Trans-Northern, has stated that, even when the pipe line is completed, the demand for petroleum products would make it necessary to utilize existing tanker fleets to the fullest possible extent. Horne, internationally recognized pipe line authority, declared that the proposed inter-city line would



21,716 hours without forced shutdown

...and still going strong

that's the record of this Alco Diesel Engine at Barnett Station of Shell Products Pipe Line

Listen to Mr. C. C. Curvey, chief operator at Barnett, Ill., speaking:

"The unit operates 24 hours a day and is never shut down except for the annual routine inspection and overhaul. . . . Not only have we boosted capacity of this line 15%, but operating and maintenance costs have been much reduced."

The Barnett station is equipped with a single Alco diesel—replacing a total of 3 old-type engines. This rugged Alco diesel provides power for pumping 1,050,000 barrels a month through the 8-inch pipe line. It's a 6-cylinder, 4-cycle engine with 12½ inch bore and 13 inch stroke, rated at 810 hp and 650 rpm.

Such power and performance can be yours, too, if you install Alco Diesel Engines to meet your pipe line pumping requirements. Your nearest Alco engineer will be glad to help. Call him today at sales offices in New York, Beaumont, Chicago, Cleveland, Houston, Kansas City, San Francisco, Schenectady, St. Louis.

SPEED Vs. WEAR

Remember, since piston speed and journal travel per minute are both almost the same in medium speed and slow speed engines, wear is equivalent as well. Not only do you get unequalled dependability with Alco Diesels—you get long wear and low maintenance costs, no matter how difficult the service conditions.

ALCO DIESELS

THE MARK OF MODERN ENGINEERING

AMERICAN LOCOMOTIVE COMPANY

require less steel than it would take to expand tanker fleets and marine storage bases to serve the fast-expanding market for petroleum products in eastern Canada.

"Apart from the fact that the pipe line would conserve an appreciable volume of steel now needed for defense purposes," he said, "it would be of inestimable value if by any chance a third world conflict were to be precipitated."

Western Pipe Lines' route of 1200 miles of 22-in. pipe and several branches totaling 400 miles of varied diameters, will require an aggregate of 37,400 hp for 10 pumping stations.

"The line, to be constructed across the western Canadian prairies, presents few construction problems in point of gradient, curvature, and other details," L. D. M. Baxter, president of the system, explained. "The only difficulties are to be found in the northern Minnesota area. There the proposed route follows closely the Interprovincial Pipe Line, recently constructed. It is not possible to outline too definitely certain of the more technical details, inasmuch as the continued work that is being done not only on the markets, but also on the pipe line, dictates changes as conditions are altered."

Via Winnipeg to Lake Head At Duluth

The line contemplates drawing its supply of gas from the Pincher Creek, Pendant d'Oreille, and other southern Alberta fields. It will originate at a point near the former site and follow a route through Swift Current, Brandon, and Winnipeg, thence due south to the International Boundary and, so to Duluth and Superior, with numerous laterals to supply other marketing areas. It is estimated that 58.4 billion feet of gas will be required per year, of which 19.5 billions would meet Canadian needs.

Among the lines organized for the export of natural gas from Alberta to the United States is the Canadian-Montana Pipe Line, to be operated jointly by a Canadian company of that name and the Montana Power Company, with respective headquarters at Calgary and Butte. F. W. Bird is president of the former and J. E. Pritchard heads the latter. The route is from the Pakowki Lake area in Alberta to Cut Bank, Montana, a distance of 72 miles. The diameter of pipe will be 16-in. OD, API 5LX42. Of the total mileage, 99.8 per cent will be underground; 2 per cent under water. Contractors and fabricators of materials and services are: for the Canadian side of the Border, Canadian Pipe Line Company, Edmonton; for the American side, Engineers Limited Pipe Line Company, San Francisco, California.

Of several routes filed by the Northwest Natural Gas Company, a line starting at Pincher Station, Alberta, is favored from an engineering standpoint. It would run westward through Crow's Nest Pass to Kingsgate, British Columbia, thence to Sand Point, Idaho, and Spokane, Washington, and continue westward to Monroe, Washington. There it would split into two sections, one proceeding north to the British Columbia market, the other to the Seattle-Portland area, with various laterals to supply specific marketing areas. The company proposes a grid system to draw the gas from Pincher Creek and other Alberta fields.

Lines to Tap Farthest North Areas

Westcoast Transmission is yet another projected pipe line that would draw its gas from the Pouce Coupé field in the Peace River area of extreme northwestern Alberta. The line would run through Prince George, a vital northern center of British Columbia, to a point near Vancouver, where it would split, one branch heading toward that city, the other to cross the International Boundary to Washington and Oregon for disposal of export surplus. An eventual branch from the vicinity of Prince George, through Yellowhead Pass to the Edmonton area, would thus enable the system to draw upon both the Peace River country and the fields north and west of Edmonton.

A short natural gas line already extends from the pioneer Alberta fields to Dawson Creek, British Columbia, a far northern community of great strategic significance and the scene of winter tests and maneuvers of the Canadian armed services. * * *

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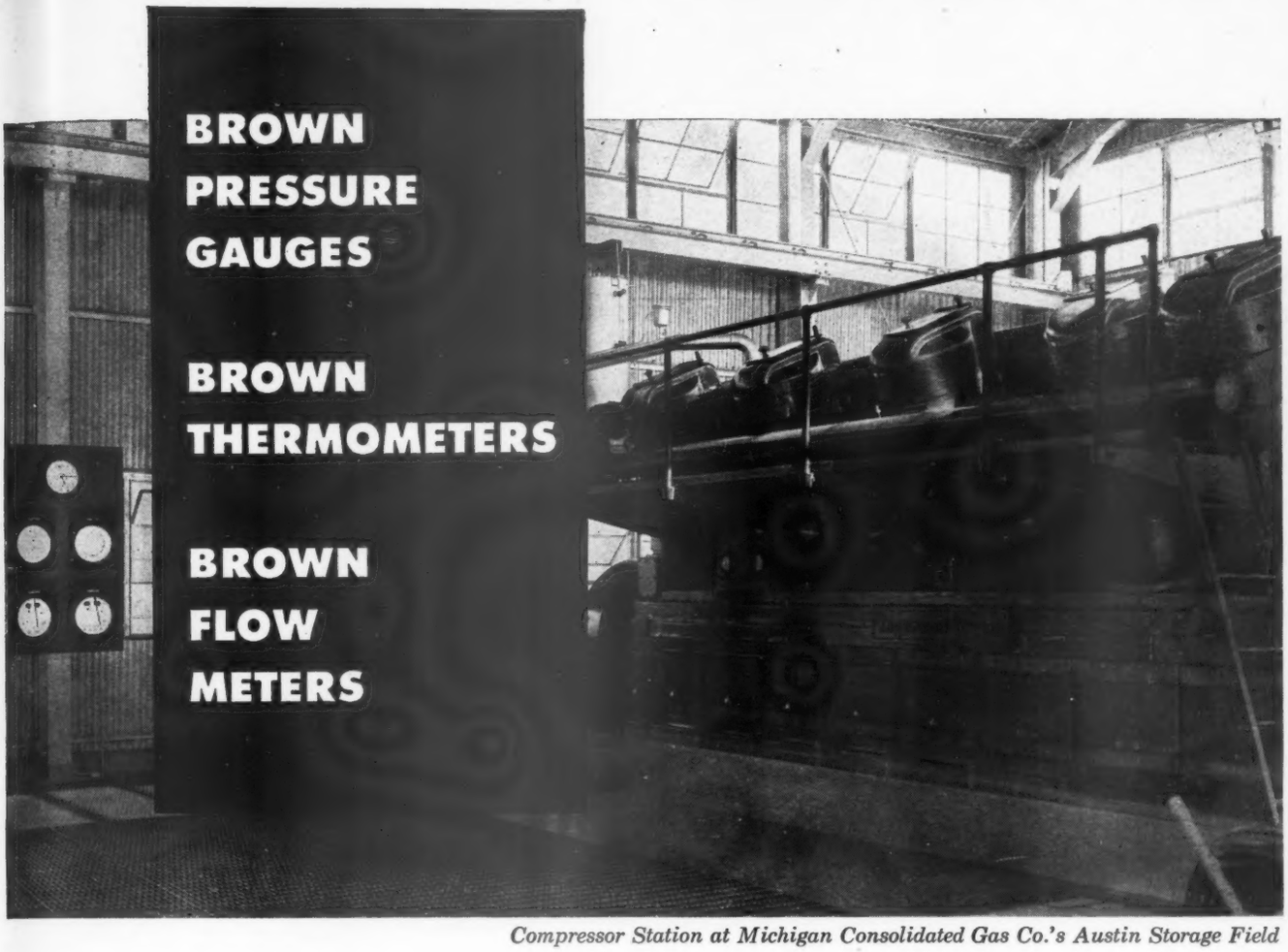

Compressor Station at Michigan Consolidated Gas Co.'s Austin Storage Field

Valuable guides to
COMPRESSOR STATION EFFICIENCY

NEVER, we believe, has an operator of a compressor station ever under-estimated the importance of instruments in his job. We know that in the majority of stations (Honeywell equipped) instruments are the operator's most valued guides to efficient station operation.

Most popular of compressor station instrumentation are the Brown Pressure Gauge, Brown Thermometer and Brown Flow Meter. These not only simplify operation through accurate, permanent records of gas flow and pressure but they provide the best kind of insurance in protecting valuable compressor equipment. Positive protection of engines is provided by recording and rigidly controlling the temperature of jacket cooling water.

Data Sheet 7.2-3 gives complete details on compressor station instrumentation. For details on telemetering of measurements over long distances, send also for Data Sheet 9.1-10. Write for your free copies.

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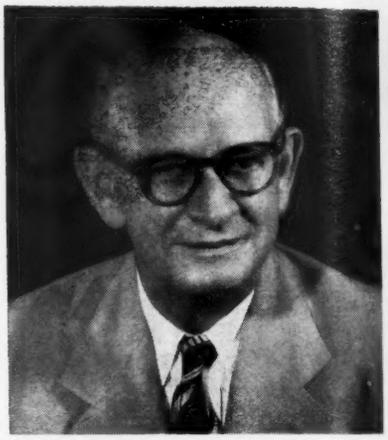
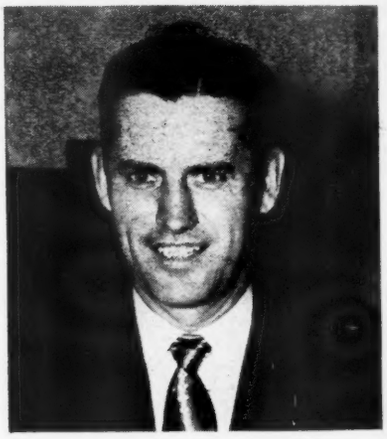




P 605.

THIRTIETH ANNIVERSARY
H. C. PRICE COMPANY

From a one-machine welding shop a multi-million dollar pipe line construction firm has been built

AN electric welding shop with one machine that wouldn't work saw the beginning of an organization that today is one of the foremost in the field of pipe line construction—the H. C. Price Company of Bartlesville, Oklahoma. That was 30 years ago. The date was November 1.

During the three decades that have intervened, an enviable record of service to the oil and gas industry has been established by this company. Building on his faith in electric welding, H. C. Price has fashioned a multi-million dollar firm having 20,000 miles of pipe line experience behind it. His crews have worked in 33 of the United States, Canada, Alaska, South America, and the Middle East. More than 100 companies have employed his organization, and one of the proudest claims of the construction firm's head is the amount of "repeat business" he has received from these companies.

Incidentally, and as is obvious, the machine that wouldn't work did not discourage the owner of the welding shop. In fact, investigation proved that it merely had been hooked-up backwards, and the young business man went on to increasingly greater accomplishments to arrive at his present stature in the pipe line construction industry.

A Young Man Goes West

Born December 28, 1888, in Washington, D. C., young Harold Charles Price paid heed to Horace Greeley's admonition to "go West". After several years as a rod-and-chainman on surveying crews in Colorado, he entered the Colorado School of Mines in 1909. Four years later, after spending summer vacations working in metallurgical plants and assay laboratories, he graduated as an engineer of mines.

His first job after college was as chemist and engineer for the New Pennsylvania Mines Company at Montezuma, Colorado. Later he served as chemist at American Metals Company, Salida, Colorado. Next stop was Oklahoma where Price first got acquainted with Bartlesville while acting as superintendent at the zinc oxide plant on the outskirts of the bustling little oil and cattle town. Despite temptations to move elsewhere, he has kept his home and busi-

H. C. PRICE CO.

30th Anniversary

Celebrating 30 years experience and 20,000 miles of pipeline achievement.

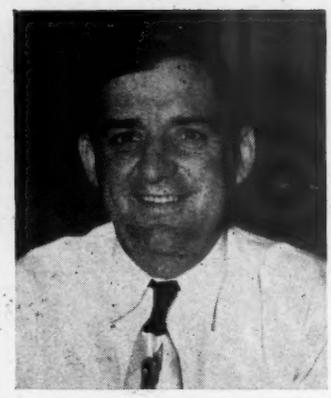
When Hal Price opened a one-machine electric welding shop in Bartlesville, Oklahoma, on November 1, 1921, the oil and gas industry was in the adolescent stage. . . . Price's successful application of electric welding to pipelining has contributed in no small degree to the tremendous expansion of America's vital pipeline network. . . . It also helped establish Price as foremost among pipeline constructors, a position maintained by skill, integrity and dependability. . . . Today, with 20,000 miles of pipeline experience, the H. C. PRICE CO. looks forward to continued service to the oil and gas industry.

PIPELINE
PRICE
CONSTRUCTORS

PHILADELPHIA • BARTLESVILLE • NEW ORLEANS

America's Foremost Pipeline Constructors

R. K. SHIVEL
Spread Superintendent



G. A. REUTZEL
Spread Superintendent

C. R. ICE
Spread Superintendent

C. E. SHIVEL
Spread Superintendent

ness headquarters in this same community, where his civic and philanthropic activities are well-known.

When America found herself involved in World War I Price joined the Coast Artillery, being discharged in 1918 as a first lieutenant. For a few months he remained in the East as assistant manager of employee relations at the American Metal Company's plant at Langeloth, Pennsylvania.

Within 18 months after his return to the Bartlesville Zinc Company as manager of employee relations, the plant was forced to shut down in the recession of 1921. Price was out of a job, but an idea was burning inside of him. This idea revolved around the little-known technique of electric welding. Price foresaw the day when the electric spark would replace acetylene as the principal means of welding. Unknown to him at the time, the genus of this idea marked the first important step in an illustrious career.

Humble Start

Certainly it was an inauspicious beginning when the Electra Welding Company opened for business on November 1, 1921, in a one-story shop on Second Street in Bartlesville. A loan of $2500 from his brother had enabled Price to purchase a single welding machine and hire two assistants. This was the aforementioned welding machine that at first wouldn't work.

Despite its meager equipment, Electra was still one of the few electric welding shops in the Southwest. The scope of its activities remained limited until the fall of 1922 when the company was given the job of repairing the leaky bottom of a 55,000-bbl storage tank for the Empire Pipeline Company in the El Dorado, Kansas, oil field. Eleven thousand pounds of welding rod were required to weld the 2867 ft of seams and 22,936 rivets, but the job proved successful. Not only was it the first tank bottom to be repaired by electric welding, but it also meant sufficient reward financially for Price that he closed his little shop in Bartlesville and began contracting tank welding in the field. The firm's name was changed to Welding Engineering Company and with a growing demand for electric welding of storage tanks Price was hard-pressed to train competent welders.

Even while it was rapidly growing into the largest electric welding contractor in the Mid-Continent area, the Price organization was getting its first taste of pipelining. This was in 1922 for the Empire Gas and Fuel Company at Caney, Kansas, where shop welders were used on a job that included only 150 joints of 12-in. pipe. Although none of the joints broke, the numerous pin hole leaks made the line resemble a sprinkling system when it was tested with 300-psi water pressure. Discouraged, Price concentrated on welding oil field storage tanks for the next six years, little realizing that pipelining would prove to be his big opportunity.

Initial Pipe Line Success

In 1928 Price was awarded the contract for field welding of a 169-mile stretch of 8-in. oil line from San Augustine to Corsicana, Texas, for The Texas Pipe Line Company. Up to that time a few short pipe lines had been electric welded, but the Texas company project was the first to exceed 50 miles in length. Equipment consisted of 18 welding machines mounted on farm wagons drawn by horses or mules. Pipe was roll-welded on greased skids made from tree limbs, with a total of 20,881 welds completed in four months. With coated rod then unavailable, bare welding rod was used with welders averaging as many as 25 welds a day on the job.

When completed, the job was hailed as a success and Price's services were immediately sought on pipe lines throughout the country. In 1929 the Welding Engineering Company employed 200 men and welded more than 800 miles of line, achieving the position of the largest electric welding contractors in the United States.

A year later Price took another important step ahead. Experiments with a heavily-coated electrode known as the shielded arc indicated its possible adaptability to pipe line welding. It produced a weld that was very fine grained, free of oxides and nitrides, and therefore very ductile and tough. A 32-mile gas line, 20 in. in diameter, was welded for the Cities Service Pipe Line Company by the Price concern using the heavily-coated electrode. It was the first time that electric welding had been used on such large diameter pipe without expansion joints or couplings between the welds.

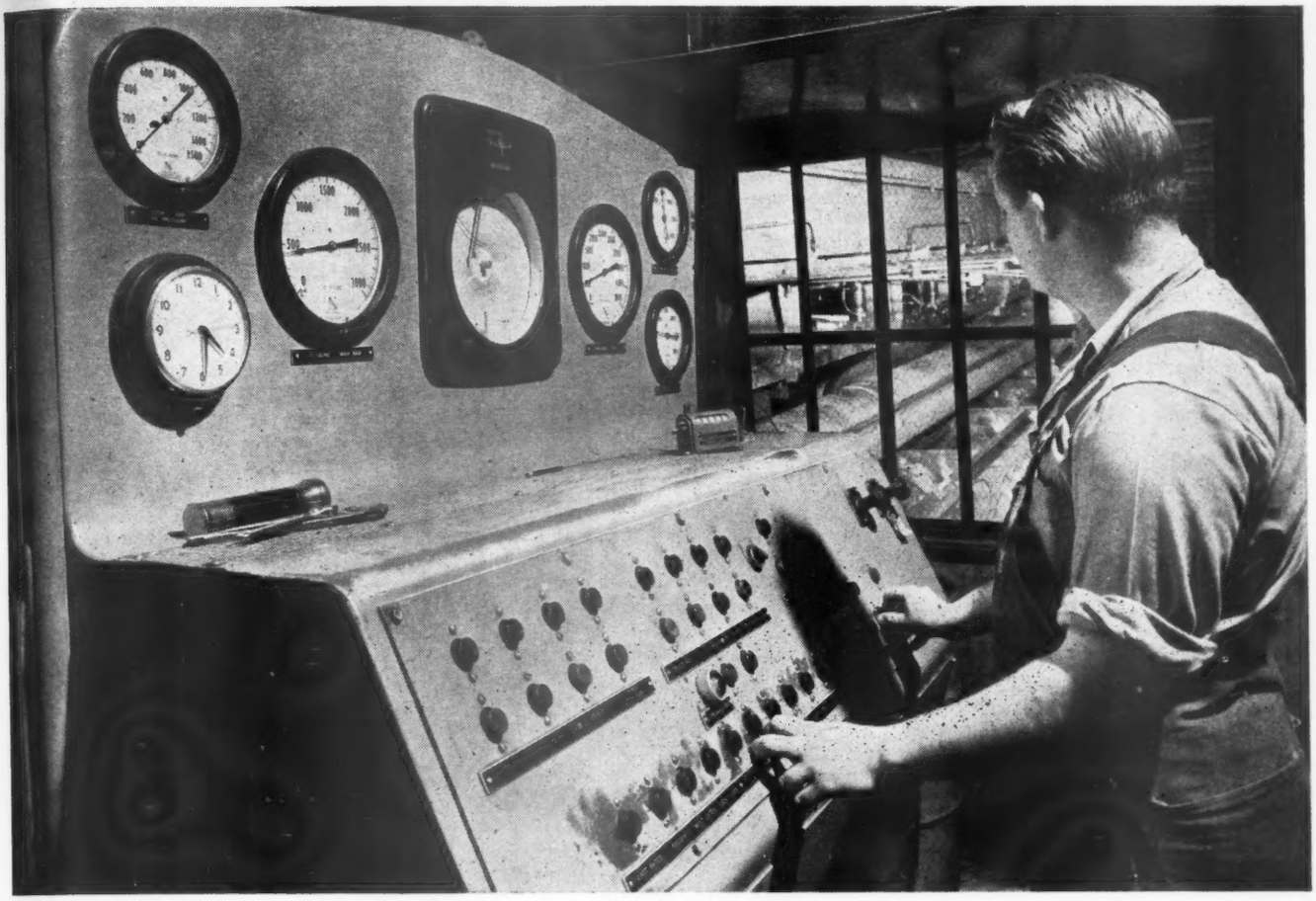
This important advancement in the art of pipe line welding necessitated a complete changeover of equipment for the Welding Engineering Company. It also implemented a lifelong friendship between Price and J. F. Lincoln, president of the Lincoln Electric Company, for the latter extended his colleague the necessary credit to replace the outmoded welding machines.

Other Advancements

During this period, while electric welding 75 per cent of the major oil and gas lines in the United States, Price turned his attention to eliminating the pesky back-up ring that was placed between pipe joints to retain the fluid weld metal. Athough the back-up ring was only a minor handicap on large diameter gas lines, it required double-belling of smaller diameter oil lines where otherwise the products flow would be impeded. This was a costly process and placed electric welding at a disadvantage competitively with acetylene welding.

In 1933, while welding 227 miles of 8-in. from Oklahoma City to Thrall, Kansas, for Phillips Petroleum Company, one of Price's welders suggested leaving out the back-up ring and proceeded to demonstrate that it could be done efficiently. As crews became experienced in the technique, the new method of welding received widespread application and eventually the back-up ring was eliminated on all pipe lines regardless of size.

Another outstanding innovation advanced by Price during the early thirties was the stove-pipe method of welding. Instead of roll-welding the pipe and then using a bell-hole or position weld to tie sections together, the pipe was lined up on skids across the ditch and immediately welded to the preceding joint of pipe with a tack weld and the first bead. The main welding gang completed the weld by adding additional beads around the pipe, which then was



He's doing 3 jobs for you

This man is operating equipment that does three important things to assure you of better Basalt-Kaiser line pipe:

It expands line pipe hydraulically within restraining dies to extremely accurate diameter, concentricity and straightness.

It strengthens line pipe through cold working—which means requirements of high yield strength specifications are met.

It tests line pipe with hydraulic pressure after the dies are opened. And while under pressure the pipe is struck blows of measured impact along the seam to further test the soundness of the weld.

Kaiser Steel pipe is being produced to conform to latest API specifications in diameters from ½ inch to 30 inches, and in lengths up to 55 feet. Shipping points are Fontana, and Napa, California.

It's good business to do business with

Kaiser Steel

KAISER STEEL PIPE SPECIFICATIONS • All pipe manufactured to latest A.S.T.M. and A.P.I. specifications

Type	Diameter	Length	Wall Thickness	Shipping Point
Continuous Weld—Threaded and Coupled	½" to 4" nominal I.D.	Uniform 21'	Standard	Fontana, Calif.
Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, Calif.
Electric Resistance and Fusion Weld—Plain End	8⅝" to 20" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5⅝" to 12¾" O.D.	Up to 55'	.188" to .400"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	22" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

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ready to be lowered in. This procedure, first used on the Hope Natural Gas Company's 94-mile line through West Virginia, proved particularly efficient in rough country and economical on small diameter pipe.

Operations Expand

After the first pipe line boom of 1930-31, the depression caught up with the pipe line industry and mileage fell off appreciably. The Welding Engineering Company continued to expand and maintain its dominant position among welding contractors, however, participating in the construction of every important oil and gas line laid during that period. In the late 1930's, with its name changed to H. C. Price Company, the organization looked for new fields to conquer.

A separate company, Industrial Engineering Company, was established in 1936 by Price and W. A. Bechtel Company of San Francisco to manufacture and distribute Somastic coating under an exclusive license obtained from Standard Oil Company of California. Applied to pipe by a continuous extrusion process, this uniform seamless coating of asphalt mastic provides protection against soil corrosion and electrolysis.

Initially most Somastic coating contracts were handled at temporary railhead plants or as "over-the-trench" jobs. Later, Price established two permanent plants near New Orleans and Philadelphia while continuing to handle some Somastic coating projects at railhead locations. On April 1, 1946, Industrial was dissolved and Price took over the exclusive manufacture and distribution of Somastic coating in the 37 states east of the Rocky Mountains.

Allied to its Somastic operations, the Price company recently developed a product known as "Hevicote" and is now making it available to pipe line owners for purposes of giving sufficient weight to marine and swamp crossings to assure adequate negative buoyancy. The "Hevicote" process places a reinforced concrete-like sleeve around the pipe in varying thicknesses, depending on the weight desired.

Incidental to the boom in the Illinois oil fields in the late thirties, H. C. Price Company further developed a method of electric field welding oil well casing. Replacing conventional threaded pipe, more than 200 casing strings were completed in one year's operations by Price crews.

A few months before World War II broke out in Europe, the Price organization was called upon to handle its first foreign job—a 100-mile section of 16-in. pipe between Oficiana and Puerto La-Cruz, Venezuela, for the Mene Grande Oil Company. Work began on April 6, 1939, and was completed on July 8, six weeks ahead of schedule. Later that year 42 miles of 10-in. were welded for the Standard Oil Company of Venezuela between Jusepin and Caripito.

The War Years

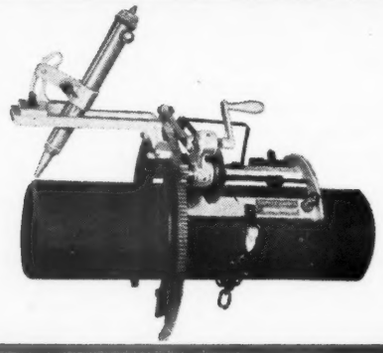
After America's entry into the second World War, the activities of the H. C. Price Company expanded on a large scale. It advanced to the role of general pipe line contractors, participating in the construction of many vital wartime pipe line projects. The company supplied foremen and welders to several shipyards and to an airplane modification plant. It aided in the construction of an ordnance plant and built helium tanks for the U. S. Bureau of Mines. At the request of the Army, a pipe line welding school was established by Price to train recruits for emergency pipe line work in foreign oil fields.

Undoubtedly the most spectacular operation undertaken by the company during the war years was the Canol Project, called one of the greatest construction feats in the history of mankind. In collaboration with W. A. Bechtel Company and W. E. Callahan Company, the organization explored an undeveloped area in Canada and Alaska that was one-third the size of the United States. It built 2000 miles of road through the wilderness, laid 1700 miles of pipe line, constructed a refinery at Whitehorse, and transported thousands of workmen and tons of material to locations 1000 miles from civilization.

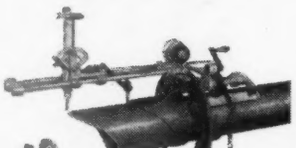
Over precipitous mountains, bogs, swamps, muskeg, and across ice-choked streams, the vital oil lines were laid in temperatures that fell to 50 deg below zero. Headed by superintendents Bob

for SPEED and ECONOMY use . . .

H&M PIPE CUTTING and BEVELING MACHINE



ATTACHMENTS



Shape Cutting Attachment for cutting the various shapes of pipe intersections.

Out-of-Round Attachment is used when pipe is out of round.

speed . . . . . Split horseshoe shaped gear permits machine to slip quickly over pipe. Fast operating snap chain fasteners hold it in place. A complete cut and bevel can be made in a 12 inch pipe in about two minutes.

economy . . . You'll soon save several times the cost of the machine in labor, gas and transportation charges. H&M takes approximately one-half the labor and gas to make the cut as hand cutting and the work is all done in the field.

portability . . Bring this light (24 to 155 pounds) but durable machine to the pipe instead of moving the heavy pipe to the machine. Remember, H&M designs for SPEED and ECONOMY.

Let us arrange a demonstration to show you how H&M will save you money and time. Or write for further details . . .

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Dunn Bros.' Crews and Trucks stringing on the Tennessee Gas Transmission Line near Selmer, Tennessee.

Efficient, experienced and well equipped personnel make up DUNN BROS.' pipe line stringing organization. Throughout DUNN BROS.' many, many years of operation, thousands of miles of pipe have been strung all over the United States, in the roughest weather, and over mountain, desert, swamp, and forest. No job is too tough for DUNN BROS.

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DALLAS, TEXAS

Shivel, Charlie Jones, Walter Sims, and Cleo Robertson the Price crews endured almost insufferable conditions in order to fulfill this important assignment.

Veterans in the Price organization remember with pride the Big Inch and Little Big Inch war emergency pipe lines. Within a few months after Pearl Harbor German submarines had destroyed an appalling number of ships along the Atlantic and Gulf Coast, resulting in a suspension of shipping in these waters and causing a serious interruption in the flow of petroleum products.

The 24-in. and 20-in. lines laid at a record speed from the oil producing areas of the southwest to the Eastern seaboard are given credit for keeping America's war machine in high gear. On the Big Inch, Price welded more than 225 miles, while on the Little Big Inch the company associated with Bechtel and O. E. Dempsey Company as general contractors to lay 80 miles.

Joint Ventures

The same three contractors joined forces to construct several important civilian jobs during the war period. These joint ventures included 180 miles of 22-in. for Panhandle Eastern Pipe Line Company, 231 miles of 26-in. for Cities Service Gas, and 324 miles of 24-in. on the original Tennessee Gas Transmission Company system. On the latter project, the newly developed Price-Elliott inside line-up clamp was used for the first time, reducing the amount of time required for welding by 50 per cent.

The H. C. Price Company emerged from World War II as full-fledged general contractors, with a quarter-century of experience behind it and an organization of trained and skilled personnel. The company has continued to maintain a foremost position in the tremendous postwar expansion of both oil and gas lines in the United States and throughout the world.

Best known of the many important projects on which Price spreads have worked in recent years are the "Biggest Inch" and "Toughest Inch." The first, built in 1947 for Southern California Gas Company and Southern Counties Gas Company, called for construction of 214 miles of 30-in. pipe between Blythe and Santa Fe Springs, California. It was the largest high pressure natural gas pipe line placed in service up to that time. The "Toughest Inch", described by many old-timers as the most difficult pipe line job ever undertaken, was built in 1949 for subsidiaries of the Columbia Gas System, Inc., and involved laying of more than 200 miles of 26-in. pipe across the Appalachian Mountains to service Washington and Baltimore.

Current Accomplishments

In the past year the Price organization has completed construction of such important projects as a 373-mile extension of Tennessee Gas Transmission Company's system to Buffalo, New York; 156 miles on the first natural gas line into New England, and 480 miles of the Texas Illinois Natural Gas Pipeline Company's huge artery to Chicago. It has also participated in several joint ventures on additional work for Tennessee Gas and the Pacific Gas and Electric Company, the latter involving more than 500 miles of 30-34 in. pipe labeled the "Super Inch".

Today the H. C. Price Company has four spreads of "big-inch" equipment, capable of handling the most difficult pipe line assignment. Under pipeline division vice president, J. B. Harshman, and manager, John M. Thomas, these spreads are headed by superintendents G. A. Reutzel, R. K. Shivel, C. E. Shivel, and C. R. Ice. Continued growth is indicated in the company's Somastic division, directed by J. S. Dewar, vice president, and R. P. White, manager, and division managers Nelson VerSoy and M. J. Lane. Its headquarters staff also includes E. L. Gallery, secretary-treasurer; John Overton, assistant secretary-treasurer; Roy Burgess, administrative assistant; Bennie G. Pierce, safety director; Sam H. Paxson, purchasing agent, and David J. Kerr, public relations director.

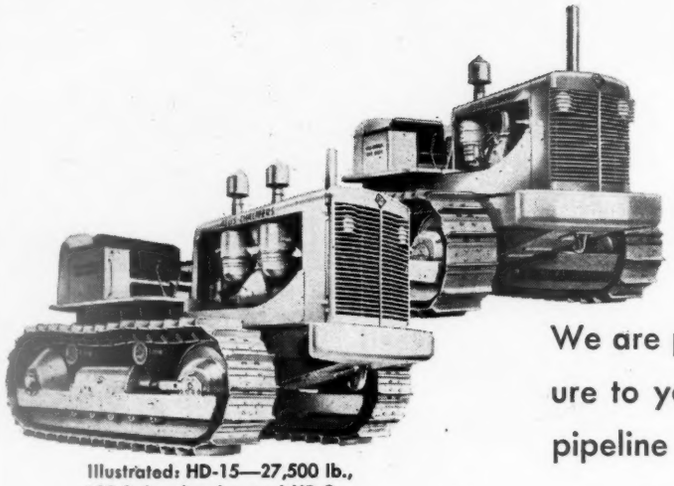
Indicative of the position of prestige achieved by the company was an elaborate article on pipe line construction appearing in FORTUNE magazine earlier this year, which gave credit to Hal Price as "the most sophisticated and

OUR HEARTIEST CONGRATULATIONS

to the H. C. PRICE CO.

on your

30th ANNIVERSARY!



Illustrated: HD-15—27,500 lb., 102.0 drawbar hp. and HD-9—18,500 lb., 70.0 drawbar hp.

We are proud to have contributed in some measure to your success as one of America's leading pipeline construction firms.

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From oil fields to refineries — on pipe lines in supply yards — Lorains have proved their ability to give cost-cutting, time-saving performance. Here are three typical operations in the petroleum industry. Each is using a different Lorain "Series" on a different mounting. Here is picture proof that the Lorain line — its various models, capacities, front ends and mountings, can do the job *better, faster, cheaper!* Thew-Lorain Distributors across the country are well-equipped to serve your every need.

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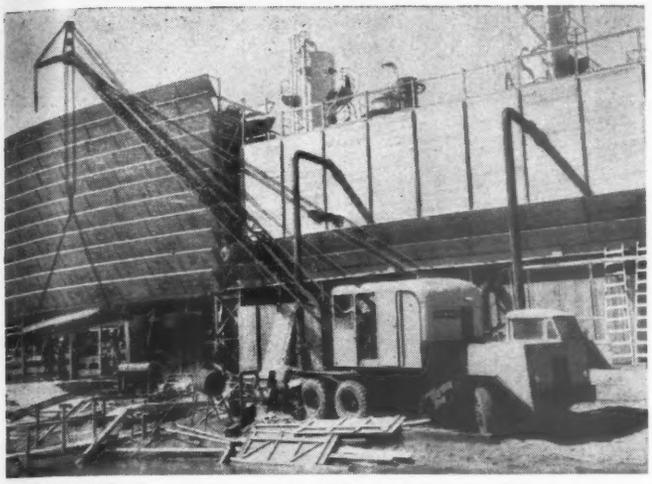
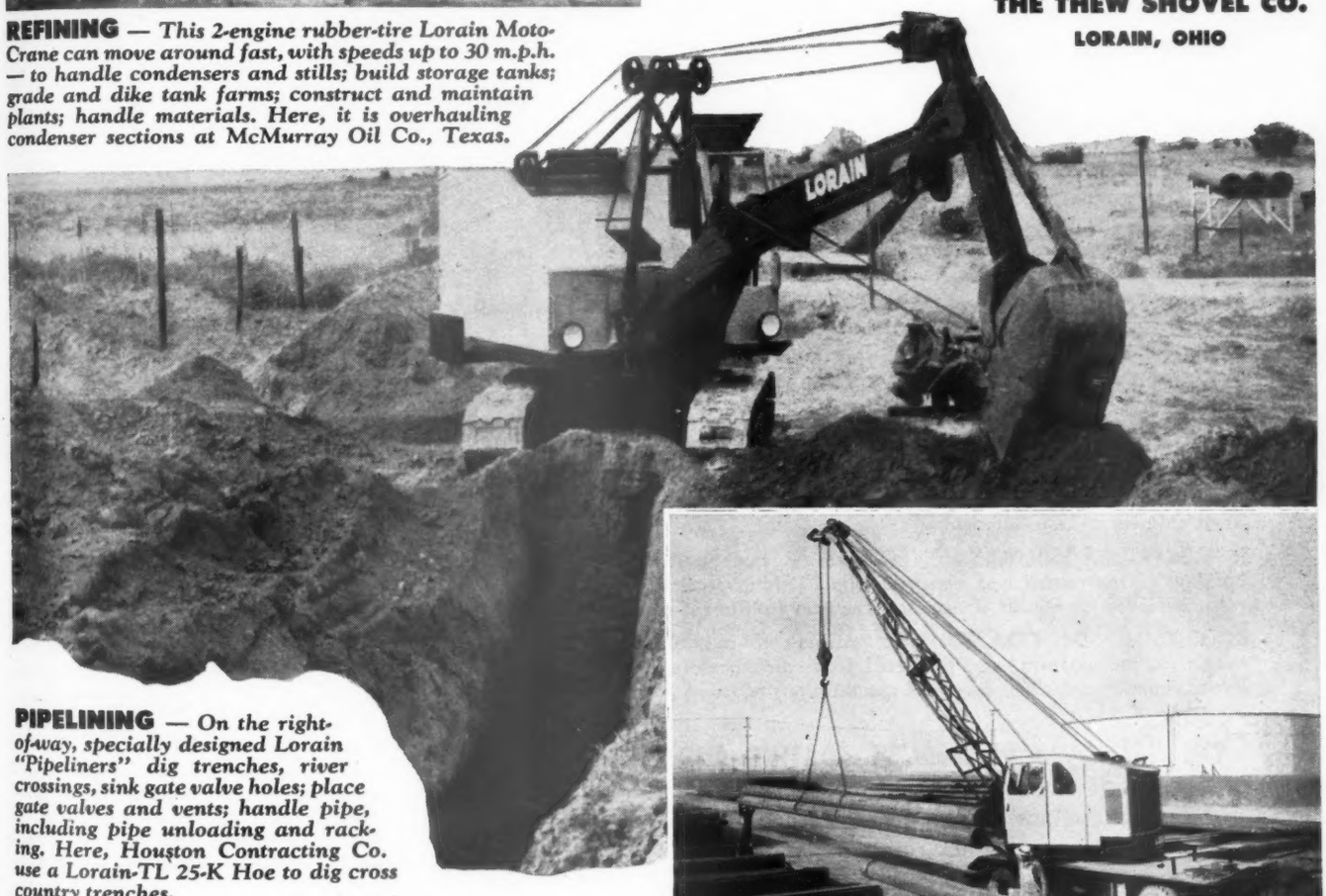


REFINING — *This 2-engine rubber-tire Lorain Moto-Crane can move around fast, with speeds up to 30 m.p.h. — to handle condensers and stills; build storage tanks; grade and dike tank farms; construct and maintain plants; handle materials. Here, it is overhauling condenser sections at McMurray Oil Co., Texas.*



PIPELINING — *On the right-of-way, specially designed Lorain "Pipeliners" dig trenches, river crossings, sink gate valve holes; place gate valves and vents; handle pipe, including pipe unloading and racking. Here, Houston Contracting Co. use a Lorain-TL 25-K Hoe to dig cross country trenches.*

SUPPLY YARD — *Shell Oil Company handle pipe at their Los Angeles, Calif. yard using a 10-ton Lorain Self-Propelled Crane. Lorains handle any size or shape material; such as, valves, meters, couplings, at a saving.*

■ FOR EVERY OIL FIELD NEED, there are 6 machine "Series" in the Lorain line — shovel capacities, from 1/2 to 2-yard classes; crane lifting capacities from 6 to 45-tons. 5 front ends can be interchanged. Mountings include 7 m.p.h. Self-Propelled and 30 m.p.h. Moto-Cranes . . . and the now famous, wide-gauge "PIPELINER" crawler hoe.

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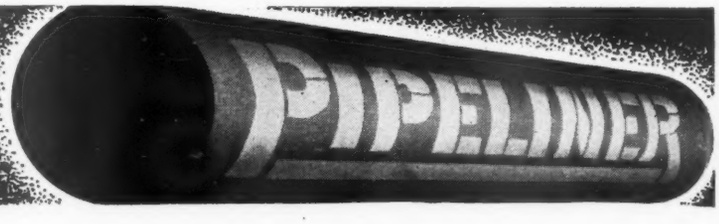

THE HALLMARK OF QUALITY COATING AND WRAPPING

standard pipeprotection inc. procedures establish the highest standard of quality for pipe protection.

1—PIPE STORAGE on rails above ground prevents corrosion of your pipe.

2—PIPE HANDLING on skidways and spoolways prevents damage to your pipe.

3—TEMPERATURE CONTROL:

a. Warm air drying of pipe before cleaning and priming.
b. High velocity warm air in primer drying.
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d. Exact temperature control of enamels during melting and application assures uniform product.
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4—STEEL GRIT CLEANING affords the best accepted method for removing rust and mill scale and etches the surface to provide maximum bond of the coatings.

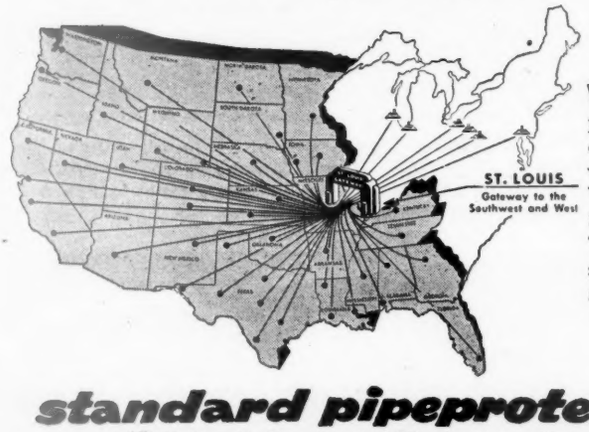
5—SMALL BATCH KETTLES and MECHANICAL AGITATION prevent alteration of softening point, penetration and filler content of enamels and eliminate any formation of carbon and so-called coke.

6—COATING AND WRAPPING EQUIPMENT, especially designed, permits versatile adjustment for different combinations of enamels, felts, glass and kraft to meet your specifications.

7—ELECTRICAL HOLIDAY DETECTORS of the latest design reveal any holidays in the coated and wrapped pipe. This inspection of every length of pipe, followed by repairs if necessary, assures fulfillment of your specifications.

8—LOADING OF COATED PIPE, nested in pyramids, excelsior-padded, strapped into one unit, and protected from dirt, cinders, and weather by reinforced paper covering, meets the specifications of the Association of American Railroads.

THE HALLMARK OF QUALITY COATING AND WRAPPING
on the kraft wrapper is evidence of fulfillment of
standard pipeprotection inc. procedures.



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forward-looking of pipeliners". It called attention to the fact that the Price organization was unique in having a company magazine, a safety department, and a regular profit-sharing plan for permanent employees. And it also pointed out that the company had the distinction not only of operating entirely out of working capital, but of working completely on a negotiated-contract basis.

While these accomplishments are indeed noteworthy, Price points with even greater pride to the large number of employees who have lengthy service records in a business notorious for its fast turnover and to the fact that in its 30 years of operation the company has not had a serious labor misunderstanding or any work interruptions because of strikes.

On its thirtieth anniversary, H. C. Price Company can look back over the years to a record of outstanding service to the oil and gas industry. And with its well-equipped, highly-trained and efficient organization it can also look forward to continued participation in the growth of this vital American business.

* * *

Texas Eastern Publishes New Company Magazine

The publication of *The Inch*, a new magazine for employees and stockholders of Texas Eastern Transmission Corporation has been announced by R. H. Hargrove, president.

The Inch, a 9 by 12, 32-page magazine with a full color cover will be published quarterly for more than 1400 employees and more than 25,000 holders of the corporation's common and preferred stock. Copies for friends and associates of the company result in a total circulation in excess of 30,000. According to the announcement, the magazine will carry news about Texas Eastern employees and operations, as well as articles about the companies with which Texas Eastern does business and information about the communities and areas where the company operates.

Many illustrations are used throughout the magazine. The feature story in the initial issue of the magazine, "Blueprints to Reality," tells of Texas Eastern's $114,000,000 expansion program, which is presently underway in Mississippi, Alabama, Tennessee, and Kentucky.

This program will add 791 miles of pipe to the system, six new compressor stations, a gas storage field, and a distribution system in New England.

Hargrove stated that in addition to the quarterly publication, an interim issue of *The Inch* prepared exclusively for employees will also be published quarterly but will be issued between the publication dates of the larger edition.

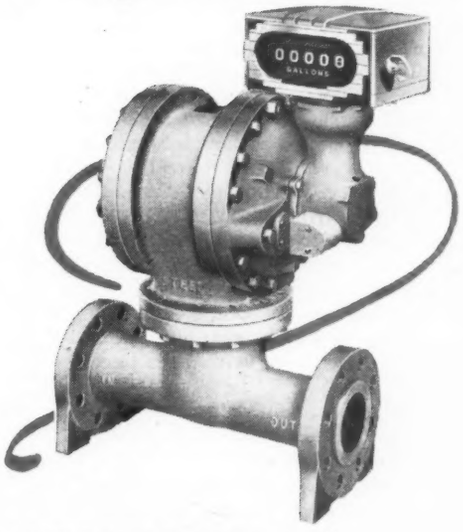
Texas Eastern's new magazines are produced by the Public Relations Department under the supervision of Jack Clarke, director of public relations. Leon M. Sipes is editor of *The Inch* and Travis K. Hickman is editorial assistant.

Meter manifold, Sinclair Pipe Line Co., Harlingen, Texas, using four type 5 PH Rotocylce meters with straight reading, set back type registers. All lines are Nordstrom valve controlled.

Made to Measure ... for Pipe Line Service

Engineered for precision accuracy, built to stand up under the toughest operating conditions—that's the story in a nutshell of Rockwell meter superiority. That's why you find these meters giving dependable low cost service, day in and day out, on major pipe line systems the country over. They accurately count the barrels as they roll through the line. They put a stop to "guesstimating" throughput, and they protect pipeliners' profits.

Want the finest pipe line meters and the skilled installation engineering counsel that goes with them? Then get in touch with the nearest Rockwell district office or write for informative literature.



Model 5 PH Rockwell Rotocycle meter with straight reading register recording in either gallons or barrels. One of five sizes, all especially designed to measure either crude or finished products at pipe line entry or take-off points.

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ROCKWELL *ROTOCYCLE* METERS

POSITIVE DISPLACEMENT METERS*

Designs are available and procedures well enough established so that PD meters can measure accurately liquid hydrocarbons.

By E. W. JACOBSON†

MUCH has been written on the use of positive displacement meters in the petroleum industry. The joint ASME-API Committee on Volumeter Research has standardized positive displacement metering practice by the development of a tentative code of recommended practice, which is under constant study and frequent revision to keep it abreast of current best practice. This paper discusses the basic standard of measurement, measuring accuracy, the fundamental concepts of positive displacement meter theory, and presents the more successful designs of meters.

Historical

From the beginning of the petroleum industry, petroleum in its various liquid forms has been a valuable commodity that must be measured as it is bought and sold on its way to final use. The care taken in measurement, and the accuracy required, has depended upon the value of the liquid petroleum being measured. For instance, crude oil has not been measured with the degree of accuracy that was desirable for highly refined products such as gasoline and fuel oil. As the precision of measurement increases so increases the cost of the measuring equipment and the measuring process. It can be said safely that in no other commercial measurement of quantity has such precision of measurement been developed as can be obtained with positive displacement meters in the present day well designed product pipe line measuring station.

Tanks, of one sort or another traditionally have been the basic standard of measurement when their internal volumes have been established by the Robinson system of "tank strapping," and the depth of petroleum within the tanks determined by accepted methods codified by the American Petroleum Institute. The Robinson method determines the tank capacity by taking and reporting the dimensions of the tank necessary for the computation of tank tables that indicate the quantity of liquid in the tank at any measured depth. The original method of depth measurement was by gage pole, later by steel tape and bob weight, both subject to noticeable error if foam or BS and W are present, and still later distant reading types, usually float operated. Floats are subject to error due to change of submergence with gravity, and to friction of the tape or chain mechanism. Tank volumes as calculated from strapping are open to error due to settlement, bottom bulges, temperature striation, etc. Errors in reading and recording by tank gaging personnel, the labor cost of measurement by tank gaging, and the high cost and scarcity of tanks has all aided and accelerated the development of equipment and methods for using positive displacement meters in the measurement of nearly all grades of liquid petroleum.

New Basic Standard

The most significant advance in measuring practice has been the establishment of the 5-gal necked test measure as the basic standard of volume. This measure, Fig. 1, has its volume "to contain" established at the National Bureau of Standards, Washington, D. C., according to procedure as outlined in the Tentative ASME-API Code 1101 for the Installation, Calibration, and Use of Positive Displacement Meters.[6]

This test measure is used in the determination of the capacities of large proving tanks according to established procedure. Some meter users have found it desirable to have necked measures in capacities of 25 gal, and 50 gal certified at the National Bureau of Standards for use supplementary to the 5-gal standard measure in calibrating large proving tanks. All proving tanks are established "to deliver" their specified volume whereas the standard 5-gal measure is specified "to contain" the volume. These carefully calibrated proving tanks are used for reference standard for positive meter measurement by frequent proving of the meters with the proving tanks according to established procedure. The terms "to contain" means that the vessel will hold a specified quantity of liquid, starting out with the interior surface of the vessel in a dry condition. The term "to deliver" means that the vessel will contain the specified amount, starting out with the interior surface wetted with the liquid to be measured. In other words, a specified amount of liquid can be drawn from the tank leaving the wetted interior.

In the past, the standard of measurement has been the strapped field tank, which has been considered correct in regard to its volume established by the tank strapping method. This new concept makes the reference container for field measurement the proving tank, which is calibrated by use of the standard test measure. The proving tank remains the established standard over a period of time, usually one year until its next calibration. Positive displacement meters are proved against the proving tank as required to maintain the accuracy of measurement required in the metering operation. This change in concept of the basic standard has been brought about by the growing backlog of experience using positive displacement meters, which indicates that measurement by well calibrated and maintained meters is more accurate than determination of quantities by strapped field tanks.

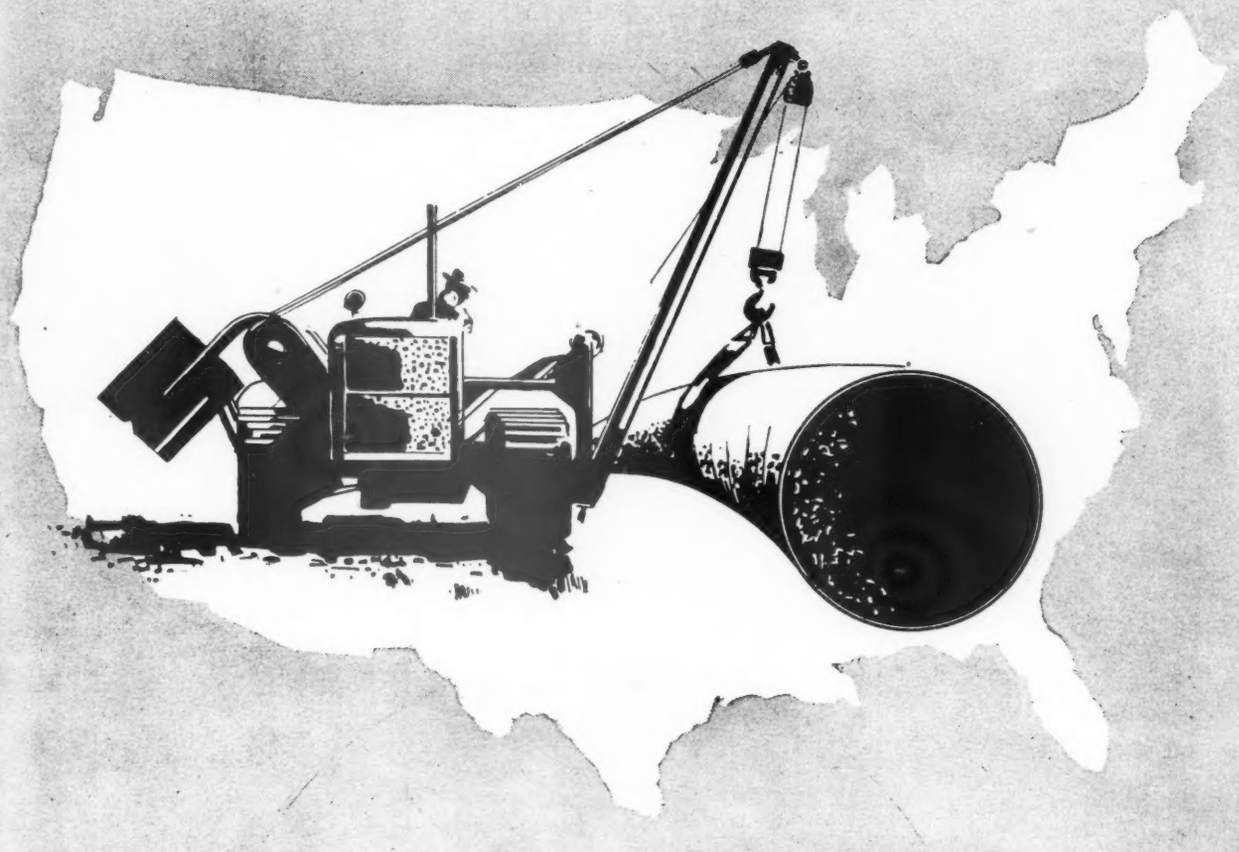
Requirement for Meters

The requirements for satisfactory and economical operation of positive displacement meters are quite well established. The liquid stream entering the meter must be essentially free of suspended abrasive solids, such as sand, pipe scale, hydrates, etc. The stream must be completely in the liquid phase as the meter will measure gas as well as liquid if there is entrained gas. In pipe line operations, metering at pressures below 100 psi is much more desirable and cheaper than at higher pressures. When planning to install meters, consideration should be given to providing adequate meter proving equipment, strainers, vapor eliminators, etc. A positive displacement meter is useless without a prover with which to make periodic check on the accuracy of the meter. The meter is only as accurate as the proving equipment that is used with it. When adequate and accurate proving equipment is provided the meter can be calibrated as often and in whatever manner is required to provide the necessary accuracy of measurement.

*Presented before American Society of Mechanical Engineers' Petroleum Mechanical Engineering Conference, Tulsa, Oklahoma, September 24-26, 1951, under the full title of "Notes on Positive Displacement Meters for Liquid Hydrocarbons."

†Chief Design Engineer, Gulf Research and Development Company, Pittsburgh, Pennsylvania.

OUT WHERE THE GOING'S TOUGH



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GAS PIPELINE CONSTRUCTION

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Measuring Accuracy

As the use of positive displacement meters becomes better understood and more widespread, the inevitable question asked by those accounting for purchase and sale of metered petroleum products concerns the accuracy of measurement to be obtained. Many have desired the positive displacement meter code to contain information on this point. The answer is that measuring accuracy depends upon many factors and cannot be tabulated. Fig. 2 shows the three equipment elements that make up the measuring team. First the standard test measure is certified as to volume. Second, this measure is used to establish the volume of the proving tank. Third, the proving tank is used to determine the meter performance. The meter then measures the liquid petroleum and the volume so measured is determined from the meter register indication and the meter performance. These four steps in the process of obtaining measuring accuracy can each be very accurately done by following procedures outlined in the Tentative ASME-API Code 1101 for the Installation and Operation of Positive Displacement Meters.[6]

As pointed out in a previous paper by this author, (1) the standard 5-gal test measure can be calibrated within 0.5 cu in. or plus or minus four hundredth per cent (0.04 per cent). Once this volume is established the measure must be handled very carefully to maintain its accuracy. A single small blow on the side of a measure may make a dent that would alter the volume 0.1 to 0.2 per cent.

In using this test measure to calibrate a large proving tank, the test measure is wiped dry inside after each withdrawal of 5 gal so that, having read the level in the test measure to less than 1/16 in. and having compensated for any change in temperature of the liquid, it is quite possible to determine the volume of the large prover within 0.1 per cent of absolute accuracy. It is therefore possible by use of uniform established procedure and National Bureau of Standards certified test measures to establish the volumes of a series of proving tanks within a variation of 0.1 per cent from absolute volume.

The original test work instituted by the ASME Fluid Meters Research Committee on Positive Displacement Meters, demonstrated that each meter should be calibrated at the viscosity, near the temperature, and at the flow rate at which it is to be operated. Recent test work[5] by Plank indicates that, with complete performance information on a particular design and make of meter, it may be able to relax somewhat the requirement for calibration of this meter on each product as it passes through the meter in certain product pipe line operations. The work of Ambrosius[3] adds further light on this possibility. By careful calibration and attention to the variables of temperature, pressure, and viscosity, meters can be expected to operate within an error of plus or minus 0.1 per cent, where such meters are operated at nearly constant flow rates and calibrated on each product being metered.

Many measuring operations such as in tank truck service and service station meters use a single meter calibration, which is applied for measurement over a range of flow rates. For an understanding of possible errors in this type service a review of the theory of positive displacement meters is desirable.

PD Meter Theory

Fig. 3 shows typical performance data for a film sealed positive displacement meter. Herein the quantity passed through the meter is plotted at various flow rates. The metering element whose motion is indicated by the register displaces a definite volume for an increment of volume indicated by the register. The metering element is an engine deriving its power from the flowing liquid stream, and drives a load made up of the register turning torque and the internal friction of the metering element. Because there is resistance to turning of the measuring element, a pressure differential exists between the upstream and downstream side of the element and some liquid slips by without being displaced. The amount of this slip depends upon the viscosity of the liquid, the pressure differential, and the mechanical clearance, etc., of the measuring element. Fig. 3 data show less slip for the more viscous liquids. The

CONSTRUCTORS OF OIL . . . WATER . . . NATURAL GAS PIPE LINES

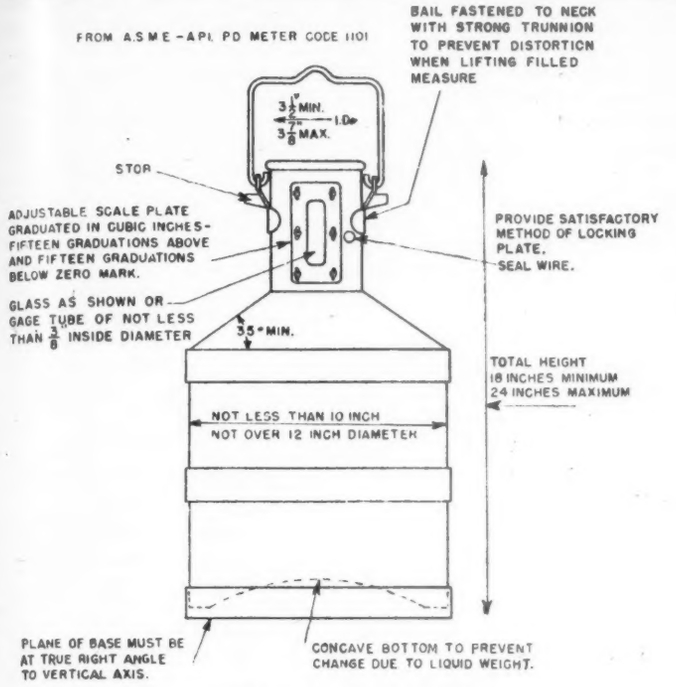
FROM A.S.M.E.-API PD METER CODE 1101
BAIL FASTENED TO NECK WITH STRONG TRUNNION TO PREVENT DISTORTION WHEN LIFTING FILLED MEASURE
3½" MIN. I.D.
3⅞" MAX.
STOP
ADJUSTABLE SCALE PLATE GRADUATED IN CUBIC INCHES - FIFTEEN GRADUATIONS ABOVE AND FIFTEEN GRADUATIONS BELOW ZERO MARK.
GLASS AS SHOWN OR GAGE TUBE OF NOT LESS THAN ⅜" INSIDE DIAMETER
PROVIDE SATISFACTORY METHOD OF LOCKING PLATE. SEAL WIRE.
35° MIN.
TOTAL HEIGHT 18 INCHES MINIMUM 24 INCHES MAXIMUM
NOT LESS THAN 10 INCH NOT OVER 12 INCH DIAMETER
PLANE OF BASE MUST BE AT TRUE RIGHT ANGLE TO VERTICAL AXIS.
CONCAVE BOTTOM TO PREVENT CHANGE DUE TO LIQUID WEIGHT.

FIG. 1. STANDARD FIVE GALLON TEST MEASURE

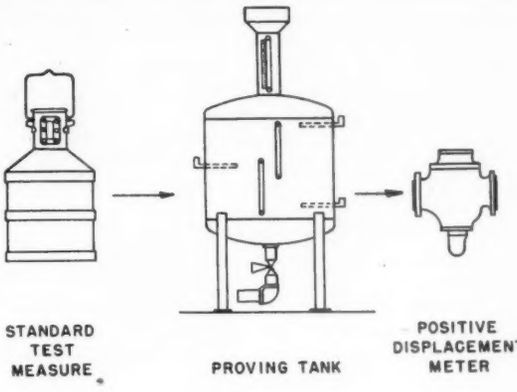

FIG. 2. THE MEASURING TEAM

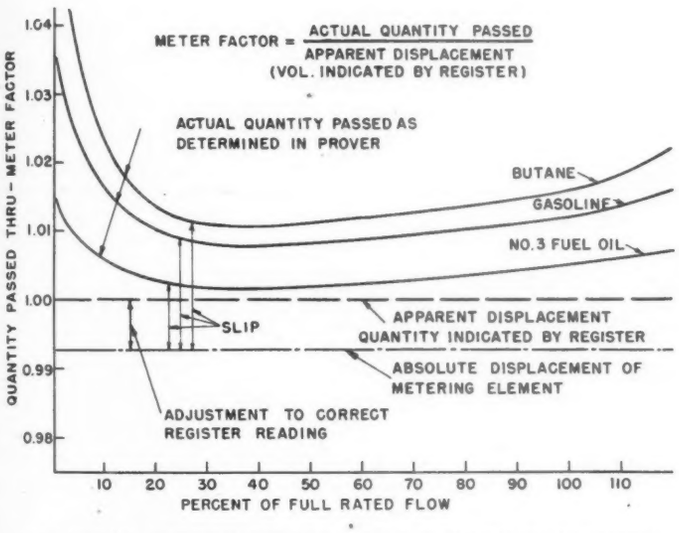

FIG. 3. TYPICAL PERFORMANCE DATA FOR A FILM SEALED P.D. METER

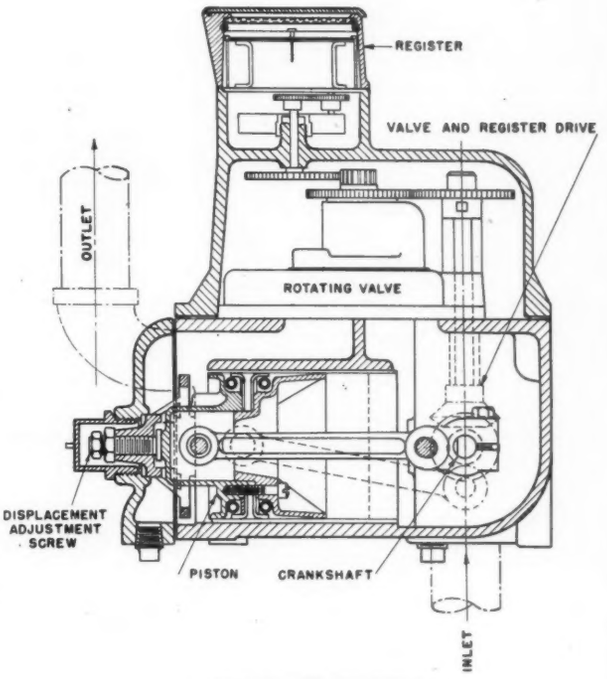

FIG. 4. PITTSBURGH DUPLEX RECIPROCATING PISTON METER

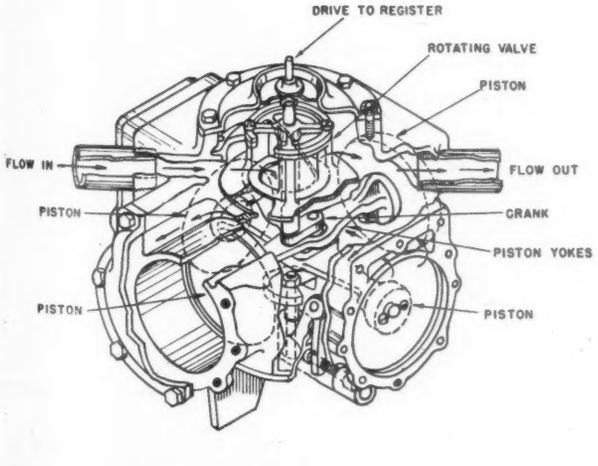

FIG. 5. PITTSBURGH 4 PISTON METER

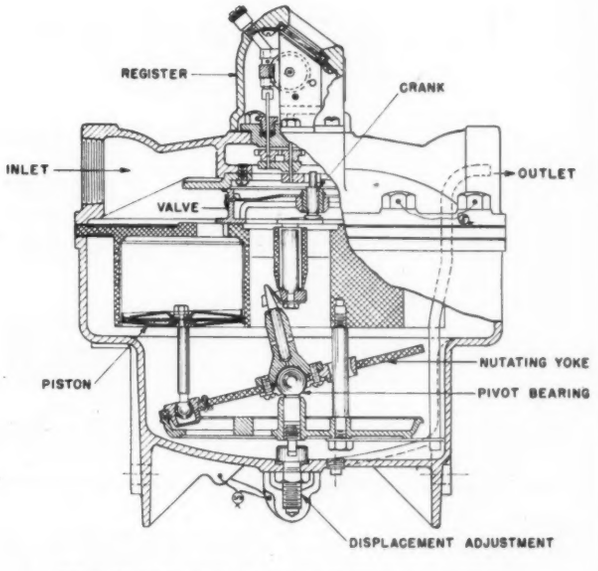

FIG. 6. BOWSER FIVE PISTON NUTATING YOKE METER

volume indicated by the meter is represented by the horizontal line designated as the apparent displacement line. The position of this line is fixed by the gearing between the register and the measuring element that drives the register.

In proving a meter to determine a meter factor for any particular flow rate on a particular product, the volume indicated by the register is considered as 100 per cent volume and the actual volume as determined in a prover when the meter indicates a 100 per cent volume is divided by the indicated volume to give the meter factor. If this meter factor is used for some other flow rate it is readily seen from the plot in Fig. 3 that an error will be introduced depending upon the deviation of the particular performance curve from the horizontal. It is also readily seen that if a meter is calibrated on one liquid and then that meter factor is used for a measurement on another liquid there will be an appreciable error introduced. The amount of this error will depend upon the design and condition of the meter. Such variation can be predicted as pointed out in Reference 5 on careful study of a particular meter.

When a meter is calibrated and a register adjustment is made so that the meter reading is used without any correction, then on Fig. 3 the apparent displacement line would be moved up so that it would cross the performance curves to give the minimum average deviation in the range of flow rates at which the meter is to measure. It is readily seen that the amount of error in this type of operation depends upon several important factors, namely, flow rate, viscosity effects, condition of the meter that governs slip at low rates of flow, and available increments of adjustment between register and metering element.

As a meter operates, some wear takes place and there is a resulting change in load and in the amount of slip so that the performance of the meter is altered. Only by observation of the change in performance with use and wear, by more or less frequent calibration, can errors from this source be predicted or accounted for.

It can be stated then that the accuracy of measurement of positive displacement meters depends upon the careful design, installation, and use of the calibration facilities, the frequency of calibration and the quality of maintenance and repair work done on the meters. A positive displacement meter is a precision instrument with which precise measurement of liquid petroleum can be accomplished. Meter users will not obtain the desired precision of measurement, however, unless the basic essentials of installation, calibration, and operation are practiced.[1, 2, 4, 6] The most successful and accurate meter installations undoubtedly will cost less than meters that are installed and forgotten until gross inaccuracies are noted and extensive and costly repairs are necessary. Successful meter measurement requires adequate technical personnel, physical maintenance of the meter installation, adequate proving, and intelligent day by day operation. The cost of operating meters is offset by savings from the following factors:[4] (a) Reduction of storage tanks required at any given facility, (b) increasing the precision of handling and cutting batches of product of various specifications as they pass down a pipe line, (c) increase in speed of handling, elimination of human errors, and increase in the measurement accuracy in bulk plant and tank truck operations, (d) providing a means of accurate, tamper proof product accounting preventing pilfering and carelessness in handling products.

PD Meter Design

There are at least eight general designs of positive displacement meters that have made good measuring devices. The pack sealed reciprocating meters were the first to be developed. These are exemplified by the duplex reciprocating piston meter, Fig. 4; the four piston meter, Fig. 5; and the five piston nutating yoke meter, Fig. 6. The early film sealed designs were the oscillating piston meter, Fig. 7, and the duplex cylindrical piston meter, Fig. 8. Need for large volume low resistance meters accelerated the development of the film sealed rotary meters exemplified by the rotary sliding vane design, Fig. 9; the rotary bucket vane meter, Fig. 10; and

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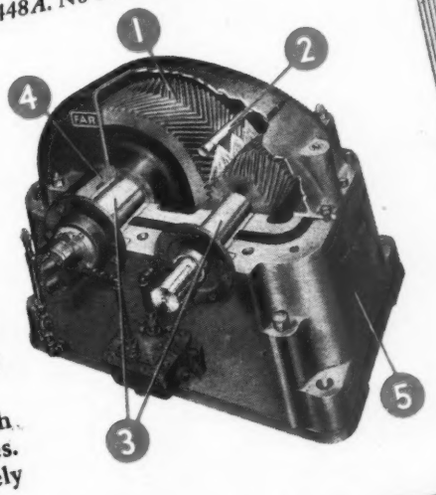

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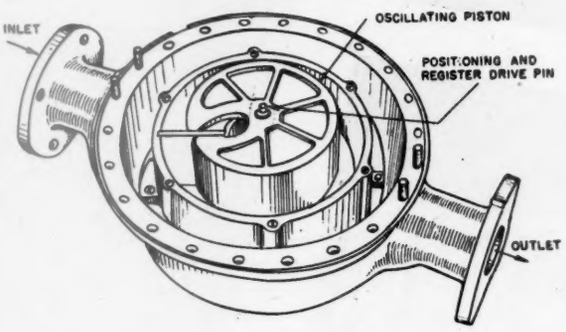

NEPTUNE OSCILLATING PISTON METER

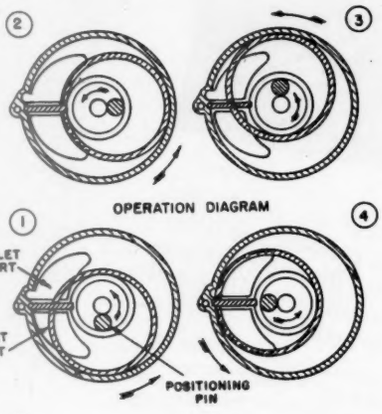

FIG. 7

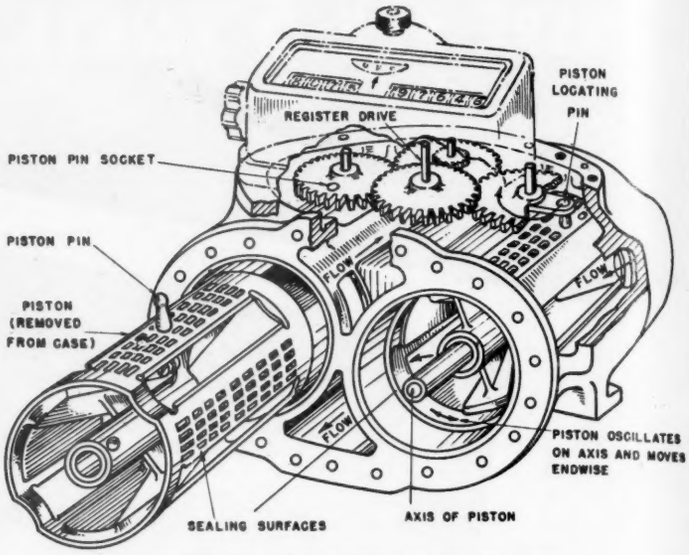

FIG. 8. BRODIE DUPLEX CYLINDRICAL PISTON METER

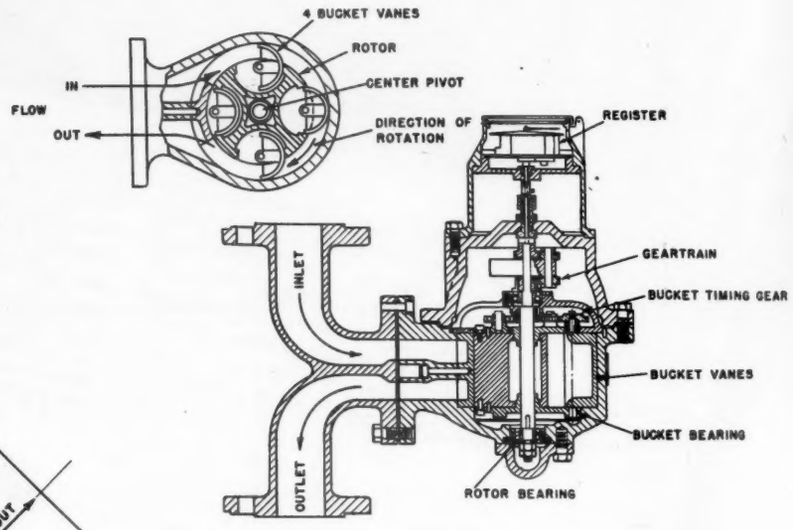

FIG. 10. PITTSBURGH ROTARY BUCKET VANE METER

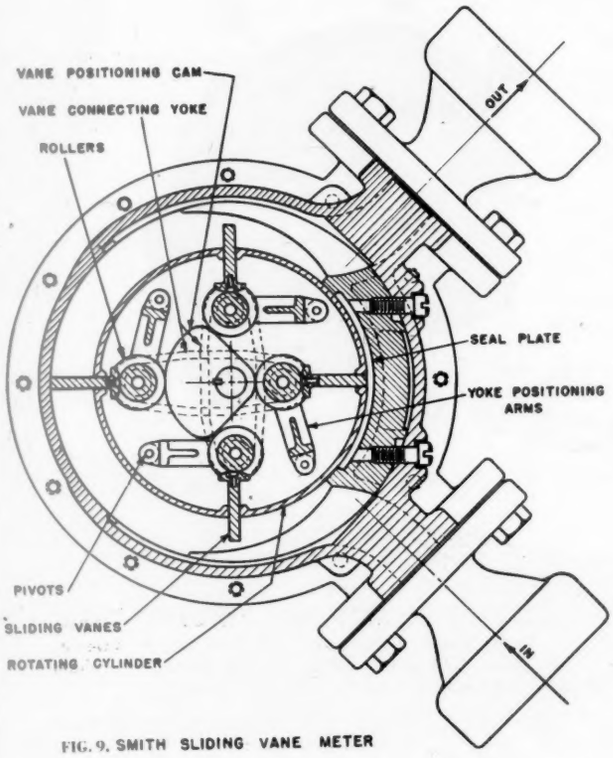

FIG. 9. SMITH SLIDING VANE METER

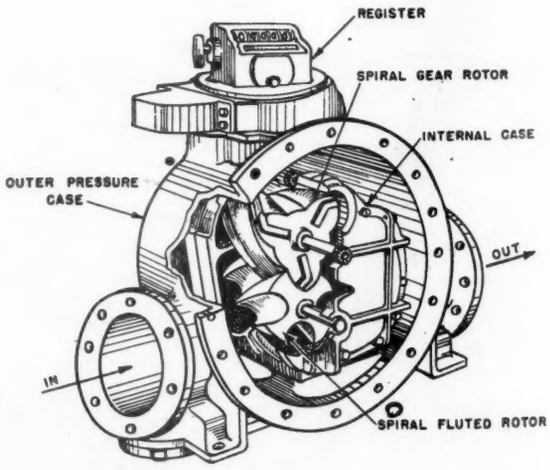

FIG. 11. BRODIE HELICAL FLUTED AND LOBED IMPELLER ROTARY METER

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recently the helical fluted and lobed impeller rotary meter, Fig. 11.

Each one of these designs has done and can do a splendid measuring job. The duplex reciprocating piston meter, Fig. 4, and the oscillating piston meter were first developed for use in service station gasoline dispensing service. They both have good power to drive bulky registers and will maintain their accuracy for long periods without adjustment. The oscillating piston meter has been giving very satisfactory service in larger sizes for tank trucks and bulk plants. The four piston, Fig. 5, has been very useful in tank truck service, however, it has been displaced in this service by the rotary type meters, which have considerably less pressure drop and less bulk for the same capacity.

The five piston nutating yoke meter as built by Bowser has been an accurate, rather high pressure drop meter that has given good service in bulk plants, and other service where plenty of pressure head was available in the flowing stream. In slightly modified design by other manufacturers this type meter has been quite satisfactory as a service station gasoline dispenser. The Brodie duplex cylindrical piston meter, Fig. 8, has been used in a wide variety of applications from crude oil measurement to tank trucks and pipe lines. It is a medium pressure drop meter, and has a minimum of wearing parts. It has given way to the rotary meter designs only because of capacity limitations.

The rotary meters have experienced rapid development and wide use. They have low pressure drop, and are much smaller in bulk for the same capacity than are the piston meters. In general their performance characteristics are not quite as good as the piston meters, particularly at low rates of flow below 15 per cent of full rated flow. When properly selected for capacity and properly installed and operated, however, their measuring capabilities are exceedingly satisfactory. The fluted and lobed impeller meter developed just recently by Brodie has shown good promise, particularly in the large sizes for ship loading, pipe line service, and the like on products ranging from Bunker C to gasoline.

The conclusion is that several good meter designs are available and that procedures for their use are well enough established that positive displacement meters can be depended upon to do a good measuring job, the cost of which can be justified by the various operational savings to be made by their use. The accuracy of measurement to be obtained depends upon the desired accuracy, the willingness of the designer to supply the necessary facilities, and the operator to follow the procedure required to give the desired accuracy.

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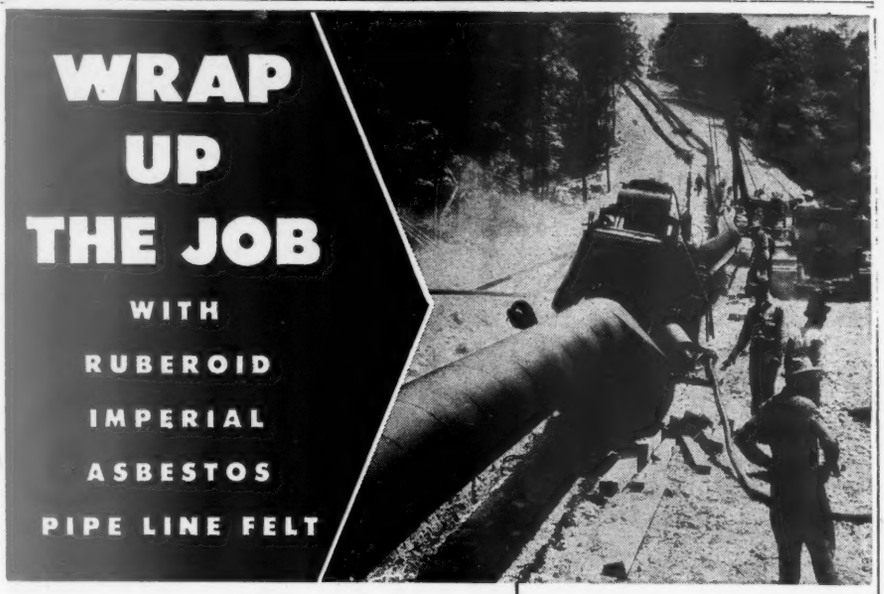
* * *

☆ ☆ ☆

Socony Launches Tug

A new 102-ft coastwise tug was launched recently by Socony-Vacuum Oil Company, Inc., in New Orleans.

The all-steel welded, 1600 hp diesel equipped tug was designed entirely by Socony-Vacuum marine engineers, and has an interior arrangement that permits passage throughout by crew members without going outside for anything but required work on the deck during rough or cold weather. Quarters for the crew of 10, the chief engineer, and the captain will have fresh air circulated continuously throughout.



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That's why Ruberoid asbestos pipe line felt was chosen as the protective wrapping for the new 26" gas line from Kentucky to Buffalo, N. Y. Built by the Tennessee Gas Transmission Company, this gas line is assured of long-range economy in maintenance by the enduring performance of Ruberoid Imperial Asbestos Pipe Line Felt.

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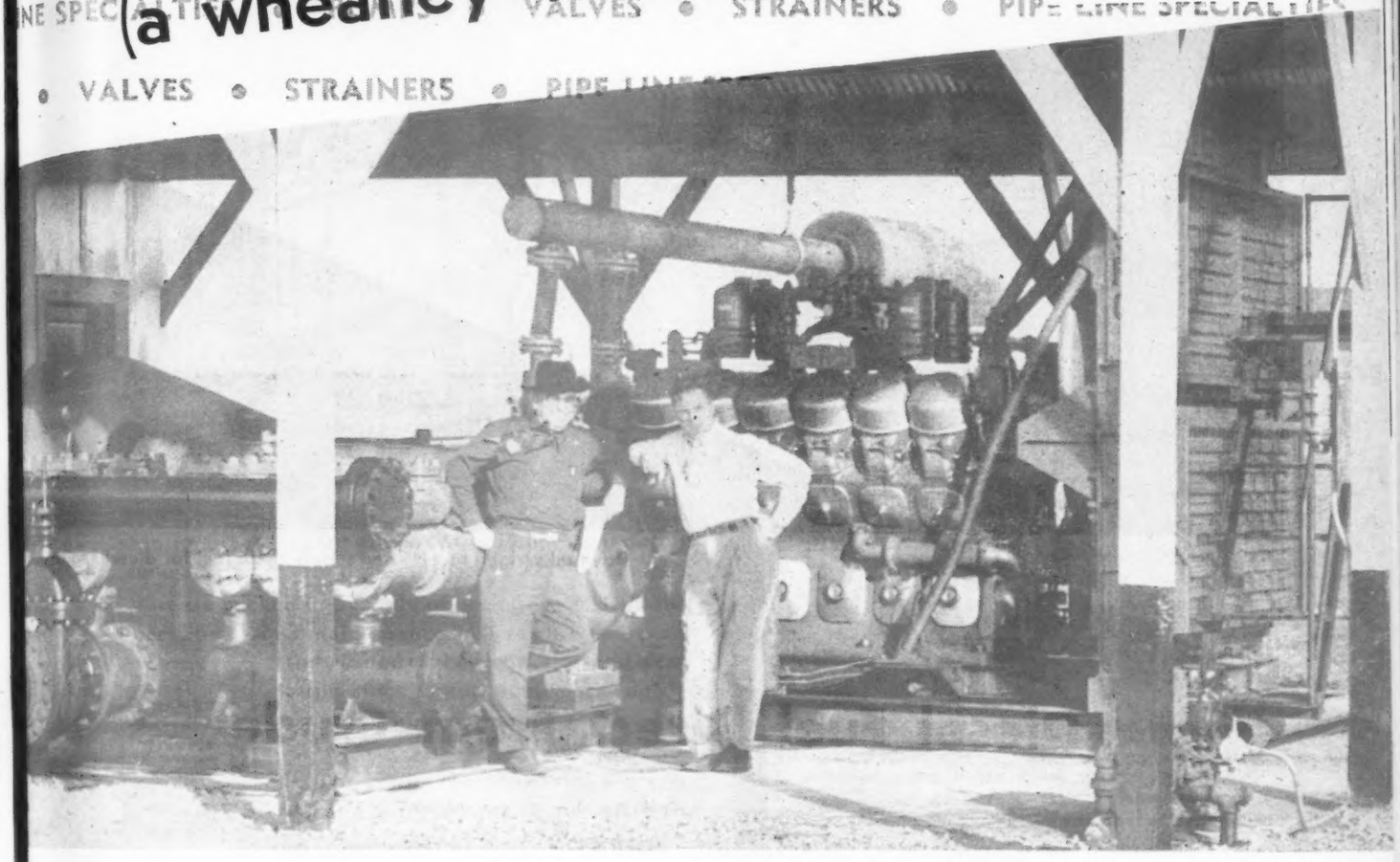

3" to 5¾" X 8", Quintuplex
Double-acting piston, Fig. 5850.

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Many of these units, along with its sister pump, the triplex, are in use throughout the oil world. Only recently has their full competence been recognized for complete pipe line systems which call for as many as twelve units at a time.

This unit challenges all competition as to size and compactness: 14,000 lbs., 7' x 9', capacity up to 50,000 B.P.D., and pressures up to 3,000 lbs. W.P. with special high pressure fluid ends. Its multiple cylinder develops 10 impulses to each revolution of the crankshaft, automatically decreasing surge to a minimum.

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*CAPACITY AT 170 R.P.M.			
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3	12,484	1605	400
3½	17,637	1137	400
4	23,581	850	400
4½	29,054	658	400
4¾	33,983	590	400
5	37,851	529	400
5½	46,174	434	400
5¾	50,428	396	400

Due to varying conditions this is recommended only with the approval of Wheatley's engineering department.

THE TREND IS WHEATLEY. COMPLETELY.

FRANK WHEATLEY
PUMPS & VALVES
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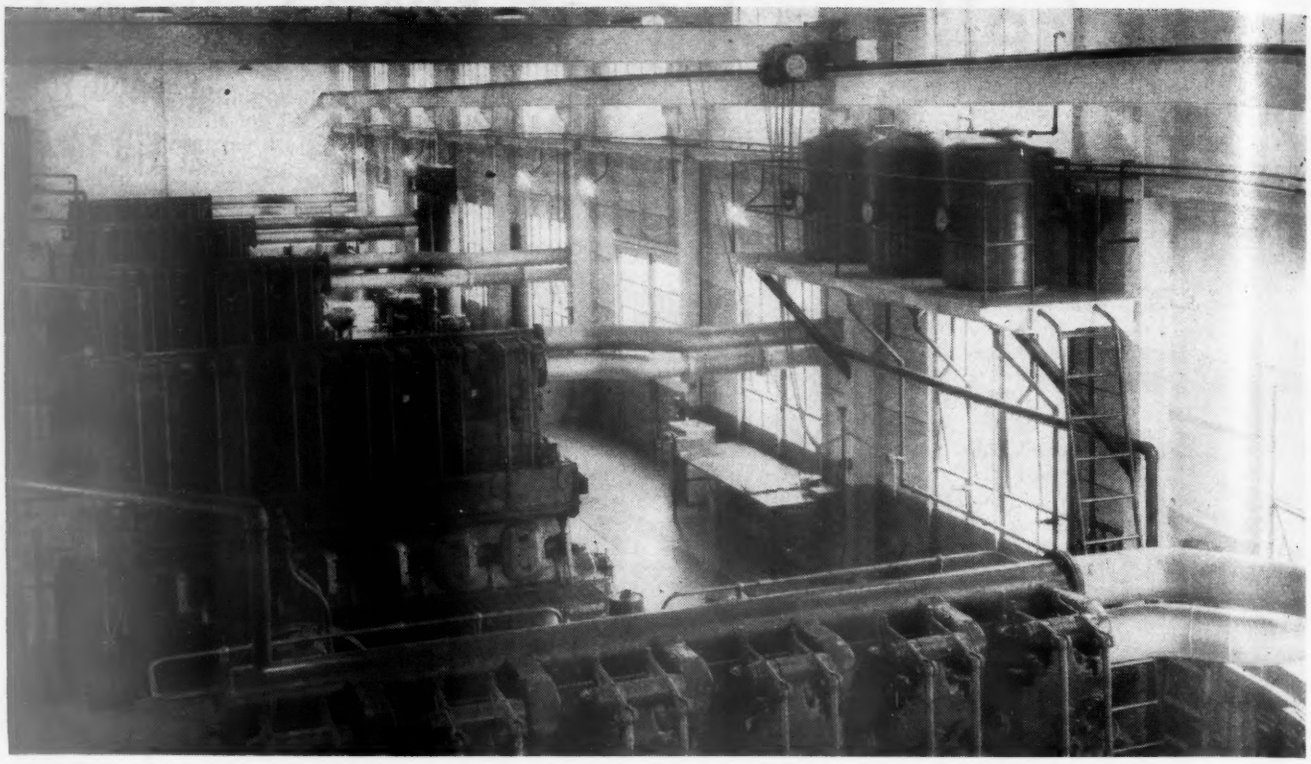


Day tanks (right) receive and supply clean fuel for diesel engines.

Diesel Fuel Direct From Crude

Centrifugal purification makes possible the use of pipe line crude oil in high-speed diesel engines

CENTRIFUGAL purification of pipe line crude oil to produce from it a first-grade, clean diesel fuel "on the job", is one of the most important developments in the economy of crude oil transportation to come in a decade. Diesel power for pipe line pumping is widespread and diesel engines require fuel that meets certain basic requirements as to quality. Although slow-speed diesels can use crude oil "as is" as fuel, the more modern medium and high-speed diesels cannot use crude as such without excessively high maintenance costs and a seriously impaired efficiency.

In fact, the diesel engine in a crude line pumping station is much like the Ancient Mariner, with "Water, water everywhere and not a drop to drink." Stations handle crude of all sorts; fuel is available in unlimited quantity, for the taking. Yet the engine, like the shipwrecked sailor, was not able to use the fuel so near by, and had to obtain fuel from other sources. And this fuel is far more expensive than that which can be produced from the crude flowing through the pumps driven by the engine, as will be shown later in this article.

Application of the centrifugal principle to the oil industry is not new by any means. Three decades ago the idea was adopted, applied, and made quite efficient to remove heavy, solidified wax from lubricating oil fractions, for example. This well known principle is that of the separation of materials of differing specific gravities by the use of centrifugal force applied in a machine properly designed for the purpose. Now, a special centrifuge and storage system has been applied to and developed for the purification of "pipeline" crude oil to produce a satisfactory fuel for use in the modern medium and high speed diesels that power the pumping stations on the line. The Sharples System has been installed in lines transporting crudes from Texas, California, Illinois, Louisiana, Wyoming, Canada, and from other sections of the western hemisphere. It has been in use long enough, and under a variety of conditions wide enough, to prove its soundness and efficiency and is being applied to more and more different conditions, all for the purpose of reducing diesel engine fuel costs with minimum maintenance and high operating efficiency of the engines.

EXCLUSIVE

Unless the crude so readily available is used as fuel, it is necessary for the line operator to purchase regular diesel fuel at a price far above the value of the crude in the line. Separate storage must be provided, which in itself introduces the possibility of contamination from tank scale, etc.; and which must be eliminated before it is fit for diesel fuel. Scale from tanks and lines, dirt and sand and other BS&W, water and/or emulsions prevent its use as an efficient fuel.

One of the most important difficulties is that of the presence of solid impurities, which are registered as "ash" in the ASTM specifications for diesel fuels. The presence of more than minimum

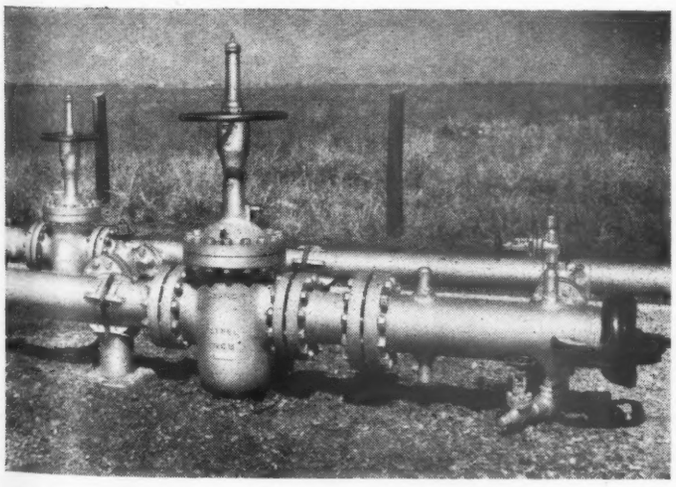
for smoother flow
easier operation
longer service life

...CRANE *CLASS 600*
OIL AND GAS PIPE-LINE VALVES

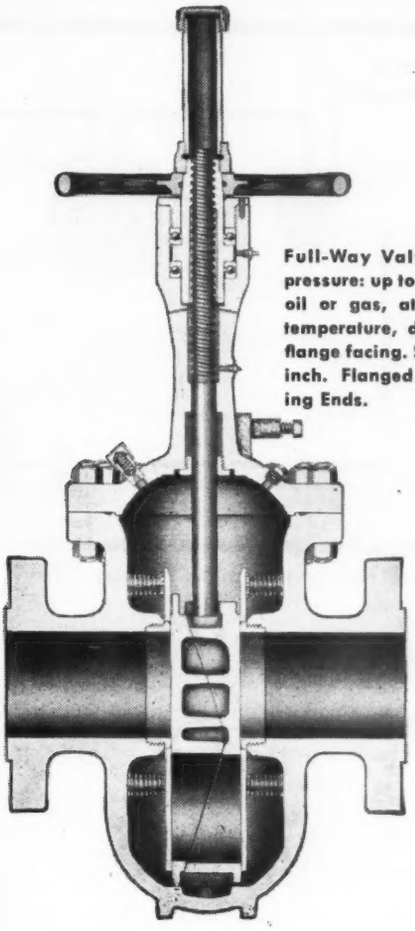
You get many advantages with these conduit-type, double-seating Crane Pipe-Line Gates. For example, smooth, full flow with minimum restriction . . . no turbulence. Circular disc ports—in perfect alignment with seat openings—eliminate pockets. This Crane design feature helps assure tight closure.

Grease packed body and bonnet assure easier valve operation . . . less maintenance. All working parts are lubricated to reduce friction and wear. And since Crane double-seating design seals off seating faces from line flow, seat erosion is eliminated.

For further information, see your Crane Representative or write for Circular AD-1864. No obligation.



Crane cast steel pipe-line gate valves on scraper trap in crude oil lines.

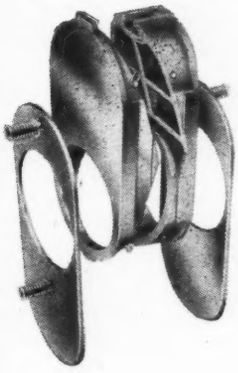


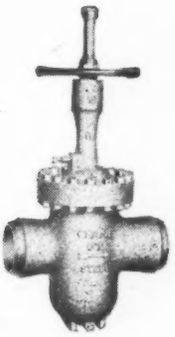
Full-Way Valve. Working pressure: up to 1440 pounds oil or gas, at atmospheric temperature, depending on flange facing. Sizes: 2 to 30-inch. Flanged or Butt-Welding Ends.

COMPLETE GREASE SEALING

Movable spring-loaded plates prevent grease entering line flow while valve is being operated . . . also close "conduit" openings in disc against entrance of grease.

In addition, plates wipe foreign matter and excess grease from disc faces and assist in guiding the disc. Readily accessible fitting in bonnet permits easy addition of grease when needed.





Venturi Type, available with flanged or butt-welding ends.

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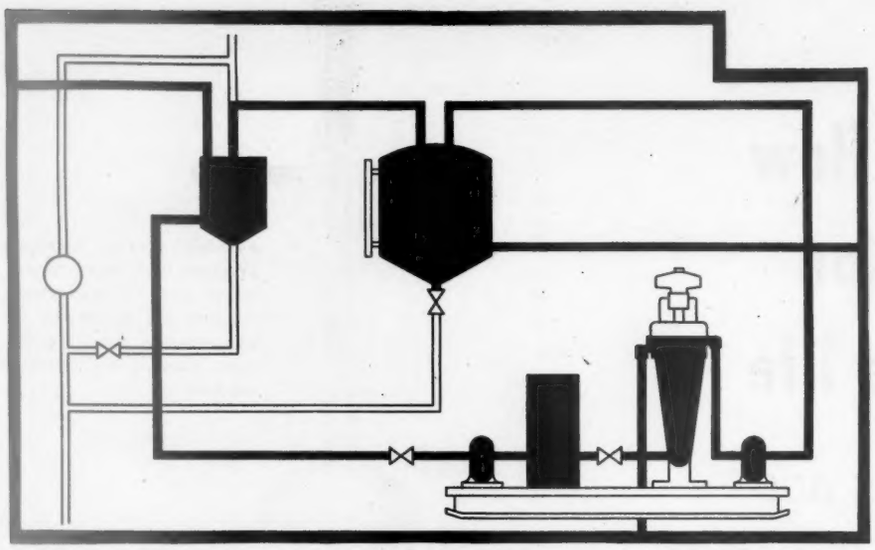


FIG. 1. Typical flow diagram of the Sharples system.

Sharples Centrifugal Pipe Line Crude Oil Purifier—Specifications

Machine size	12	13	14	15	16
Rated capacity:					
Purified oil, gallons per hour	150	200	250	450	550
Electrical data:					
Centrifuge motor hp. (explosion-proof)	1½	1½	1½	1½	2
Electric heater, max. kw	12	18	18	30	36
Connected load, max. kw (using engine cooling water for heating)	0.9	1.0	1.2	1.3	1.8
Connected load, max. kw (with electric heater)	12.9	19.0	19.2	31.3	37.8
Pumps: (positive displacement type)					
Pump suction lift, foot head	20	20	20	20	20
Pump discharge pressure, psig	20	20	20	20	20
foot head	50	50	50	50	50

Note 1: The Sharples Corporation supplies purification unit only as described above. The user supplies all tankage and external piping.
Note 2: Explosion-proof construction, throughout.
Note 3: Control equipment of magnetic type with switch provided so that in event of a belt breakage the control circuit will be broken and unit shut down.

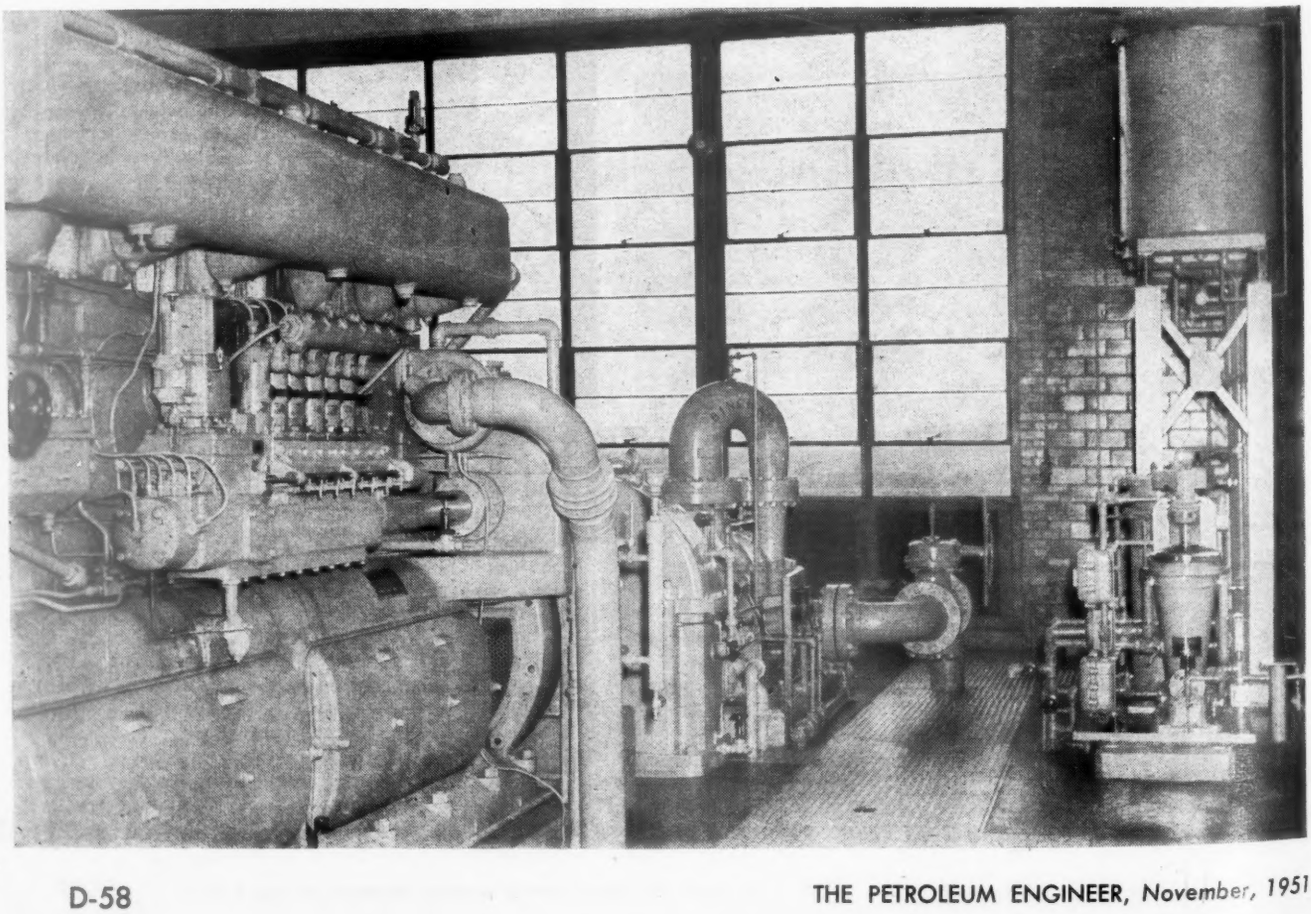
quantities of ash causes "cratering" of fuel nozzles, an extremely troublesome problem that materially reduces engine efficiency. The American Society for Testing Materials therefore properly places a rigid limit on the amount of ash in these fuels. Fuels prepared by the new Sharples System of purification meet these ASTM specifications, which means that the fuel is clean and its use will minimize maintenance costs traceable to properties of fuel employed.

Purification System

The new system includes the specially designed super-centrifuge, pumps, the heater, control instruments, and interconnecting piping, all mounted on a common base, ready to be installed in the station or plant. Lines, valves, tankage, etc., are supplied by the purchaser to fit his individual requirements. The diagrammatic layout of the system is shown in the accompanying drawing, in which clean oil is shown by gray lines, the unpurified crude by black lines.

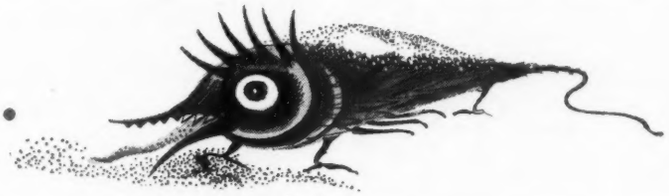
Through a bypass a stream of crude is drawn from the line and enters the tank shown at left (approximately 200-gal capacity). From this tank the oil is picked up by the positive displacement feed pump and is sent to the heater. This heater consists of coils surrounded by hot water, which water may come either from the engine jacket cooling water or may be heated by special electric immersion heaters. This indirect method of heating precludes any local overheating of the crude. The temperature to which the crude is heated is con-

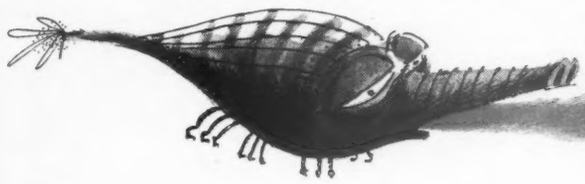
Showing crude oil purifier (right) and its location in the station building with respect to the diesel engines and pumps.



Corrosive fumes...

Salt air...





Hot air...

Moist air...

SO WHAT!

"KARBATE" BRAND *impervious graphite pipe takes it all in stride!*

Have you thought about corrosion *on the outside* of your plant piping? Fumes, salt air, hot air, moist air, can eat up *the exterior* of piping, fittings, valves, pumps, and other equipment around a chemical plant And it costs money to protect ordinary metal surfaces. You have to sandblast, use special coatings, and even then you find the corrosion creeping in and chewing up the equipment...

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Here are the advantages:

- **No exterior protection needed**
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- **Light in weight, easy to machine and assemble**
- **No metallic contamination of product**
- **Immune to thermal shock**
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trolled automatically to a given value, 105 F usually being ample to accomplish the desired result. Both intake and discharge pumps are positive displacement units, driven by the same electric motor that powers the centrifuge.

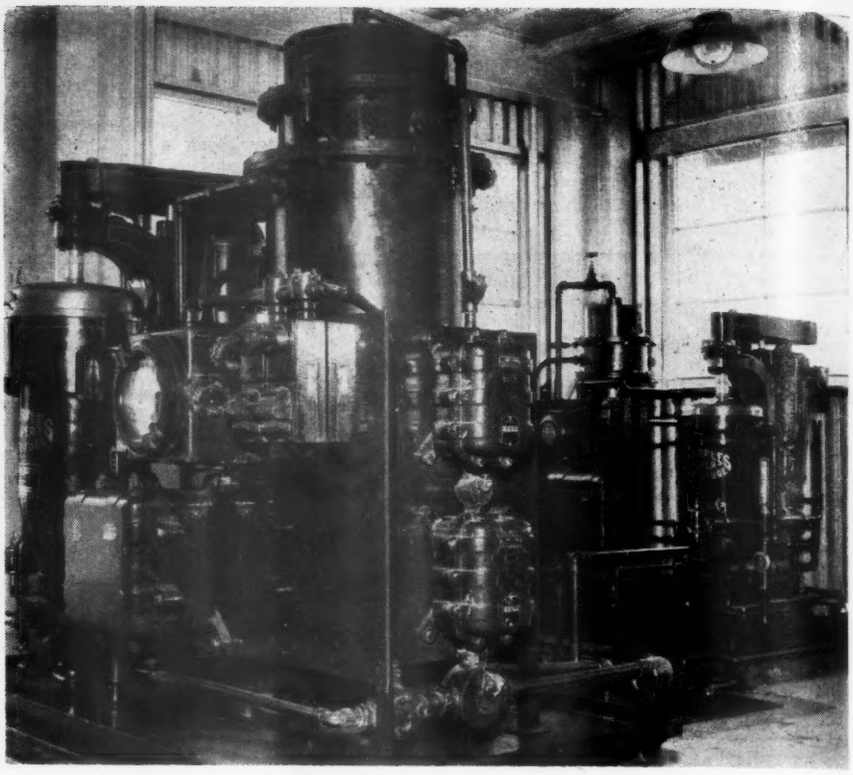
This high speed centrifuge uses a tubular bowl operating at 15,000 rpm, which generates a force of 13,200 times the force of gravity, a force sufficient to separate the unburnable solids from the raw crude. The heated crude enters the bottom of the bowl under nominal pressure, and is displaced upward by later entering crude. Solids such as wax, dirt, sand, stone particles, scale, along with water or other foreign matter, are thrown against and form a layer on the inside wall of the tubular bowl. The clean, purified oil forms the layer surrounding the center element of the rotating bowl. From the central port at the top of the bowl the clean oil destined for diesel fuel is continuously discharged and pumped to the "day tank". The solids and other impurities, together with a small amount of oil, continuously discharge from the bowl's top through another port near the periphery of the bowl, and this waste is sent to the station sump.

The clean oil storage (day) tank is kept full at all times. The capacity of the Sharples centrifuge is approximately 10-15 per cent greater than oil consumption of the engines. The excess oil overflows into the dirty oil tank. Some stations prefer to run the clean oil overflow into a standby holding tank, which in turn overflows into the dirty oil tank. The fact that the clean oil tank is kept full at all times eliminates the possibility of recontamination by condensation, and assures that there is no tank scale formed on the tank wall.

The day tank may be either inside or outside the station; if outside, it should be insulated.

The venting arrangement assures that any condensate in the vent will drop into the dirty oil tank. Should the float valve in this tank accidentally remain open, the incoming crude will rise in the vent line and be discharged to the station sump. A sight glass is provided in this line for visual observation of such a condition.

In case a standby centrifuge is provided the day tank is the only storage required for continuous operation of the purifier and of the station engines. If no standby centrifuge is installed additional clean oil storage is advisable.



Fuel oil system in foreground and lubricating system in background, at Richfield Oil Corporation's Tejon station.

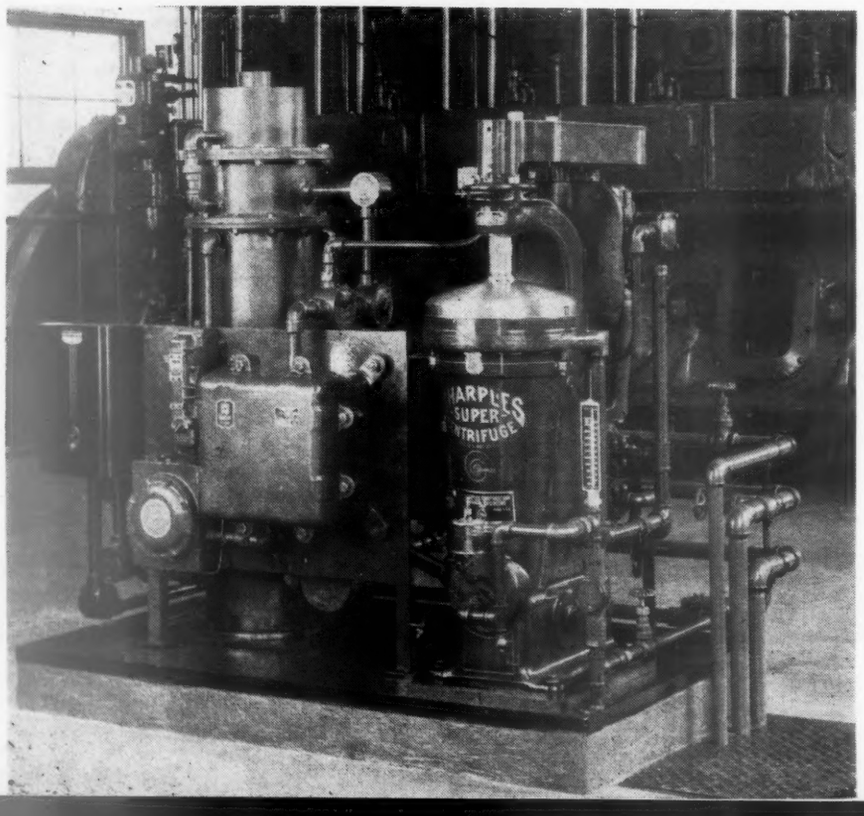
Fuel costs are reduced to the vanishing point in many cases, where the amount of crude consumed is less than the allowable losses permitted the station. In a case of 0.4 lb of fuel per horsepower-hour, 1000 hp-hr will need 50 gal per hour or 1200 gal per day. At current costs of 9¢ per gallon for regular diesel fuel this means a saving of $108.00 per day for one station operating 1000 hp.

Installations now in operation report that engine operating efficiency and maintenance is the same as when more expensive fuel oil is used.

By comparison the purification costs are negligible, because the unit, which operates 24 hr a day, requires only casual observation by the operator, and needs cleaning only once per week, a job of 15 minutes or so. All fire protection is taken care of in the unit, and it requires only a minimum of floor space. As shown in the accompanying photographs of installations, the day tank or tanks may be placed preferably above floor level. The centrifugal purifier itself is assembled on a common fabricated base, is compact and needs only about 12 sq ft of floor space for a typical 200 gal per hour capacity unit.

In the accompanying table are shown approximate data on the sizes and capacities of the main items of equipment used in units of different outputs, which show clearly the low requirements for power and capacity. * * *

Pipe line crude oil purifier at Mantua station of Buckeye Pipe Line Company.



Here is →

HIGH-SPEED HISTORY

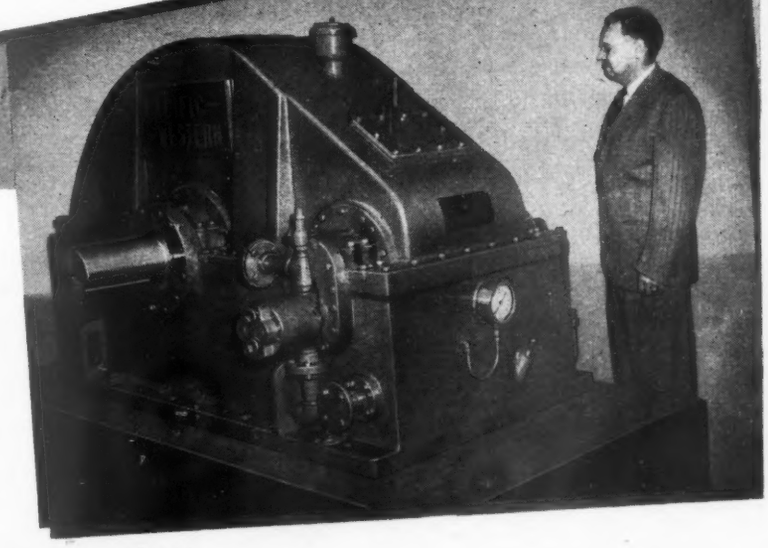
Western Gear Works

1935

The photography was bad but the engineering was good on this Pacific-Western high-speed unit. It is still (in 1951) doing its job efficiently—operating a high-speed blower. For several decades Pacific-Western high-speed units have earned enviable reputations for reliable, low-cost operation.

16 YEARS LATER

Same company, same engineer—with one of the newest Pacific-Western high-speed units, a smooth, efficient design—and above all, *dependable*. This speed increaser was built to drive a large pump.



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For standard or special high-speed units or speed reducers of all kinds . . . for any type of gearing or geared product used in industry, take advantage of our experience (more than fifty years) and facilities (four manufacturing plants) comprising the Pacific-Western organization. Our nearest Pacific-Western plant or sales office will be glad to give you prompt service on your inquiry.

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How to Determine Correct Lubrication for Engine Cylinder

W. F. SCHAPHORST

WHEN you lubricate nearly anything you must be guided by tests. You cannot always "see" the parts being lubricated, nor can you feel them to determine whether or not they are getting hot. That is why the problem so often arises regarding the correct amount of a given oil that should be used. Thus, if oiling an engine cylinder, should it be one drop per minute? Or should it be 10 drops per minute?

In the solution of your problem one drop per minute may not be enough; 10 may be too many. Even if you could look inside and see what the lubricant is doing you cannot always be sure about the correct amount without a test of some kind.

For this determination of the correct amount of lubricant a good test is the "stopping time test." Thus while feeding, say, 10 drops of oil per minute to the cylinder or cylinders, just after a long run, and while running at normal speed, throw off all load from the engine. Then suddenly shut off the fuel or steam supply. The flywheels, of course, will cause the engine to continue to run for some time, and that is the important factor in this test. How long does it take the engine to stop? By using your watch you can find the stopping time to the second. Make a note of the time required to come to a dead stop from the time the fuel or steam supply was cut off. Some engines will run for several minutes. Rotors of large turbines will run for several hours.

Then during your next run try 9 drops of oil per minute, but do not allow any other condition to be changed. If the stopping time is still the same, you may as well save 60 drops an hour, 600 drops a day, or 180,000 drops per year.

Next try 8 drops, 7 drops, 6 drops, etc. Don't use the least number that permits maximum stopping time. Use the least number plus one. In other words, don't "take chances" because any machine should always be well lubricated. Besides, it may be that you should use *more* than the 10 drops you are now using. This test will tell you the answer. Use enough oil so that the stopping time will be the highest.

To be sure, judgment must be used with this test. Do not choke down the supply of lubricant until the engine cylinder is likely to be ruined; but so long as the stopping time is at its highest you can be sure that the cylinder is well lubricated.

This test is applicable to any machine that will continue to run for a while after the motive power is shut off. It is applicable to electric motors, turbines, etc. Thus, for instance, after shutting off the current from a motor that is not loaded: What is the stopping time? This test is valuable for detecting faulty ball or roller bearings and faulty babbitting as well as faulty lubrication. And it is so simple that any operator can do it. ★ ★ ★

Inventions and new developments of American oil scientists patented during the last five years total 8179—an average of six for every working day.

Jaeger's "new standards" give more air to do 30% to 40% more work
Model 600 Jaeger Compressor (600 cfm at 100 psi) operates these two 4" wagon drills at full pressure drilling 30% to 40% more footage per hour than with any 500 cfm compressor. Jaeger's 15% to 25% higher "new standards" provide the air you need to hold full pressure behind tools that otherwise would loaf under weak 70 lbs. pressure—or operate additional tools where speed and striking power are not required. See Catalog JC-1.
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Dig

1½ to 3½ cubic yards per minute with PARSONS 250 TRENCHLINER

Model 221 ALSO SPEEDS SCHEDULES

- Smaller Parsons 221 ladder-type has full range of 30 digging feeds from 5 in. to 12 ft. per min.
- Telescopic boom digs up to 8½ ft. deep . . . quickly, easily adjusted at 1-foot intervals.
- Model 221 has 9 cutting widths, from 16 to 36 in. Special teeth and side cutters provide all width changes with only 3 standard-size buckets.
- Ask your Parsons distributor for complete facts on Trenchliner Models 221 and 250. 2 other sizes: bigger crawler-mounted 310, and utility-size, rubber-tired Model 80 offer consistent savings for every size pipeline job.

HEAVY-DUTY Parsons 250 Trenchliner sets a fast pipeline pace . . . excavates 1½ to 3½ cu. yards per minute, depending on materials, depth and width requirements. 30 digging feeds, from 3.8 inches to 9 feet per minute, provide maximum digging efficiency in all materials short of solid rock. You get clean-bottom, smooth-wall trenches 16 to 42 inches wide . . . up to 12½ feet deep.

What's more, the 250 Trenchliner maintains steady, high-speed schedules and assures lowest operating costs because every assembly is extra-heavy duty . . . from its husky, fast-cleaning buckets, to the rigid arch-type frame that keeps digging boom precision-aligned. Safety overload clutch protects operating machinery from shock-loads. 3-point frame suspension maintains equal weight distribution on uneven ground, keeps twists and strains from main frame. All add up to trouble-free operation, more feet of pipeline trench per day, at lowest cost per foot, with Parsons heavy-duty 250 Trenchliner.

PARSONS COMPANY, Newton, Iowa

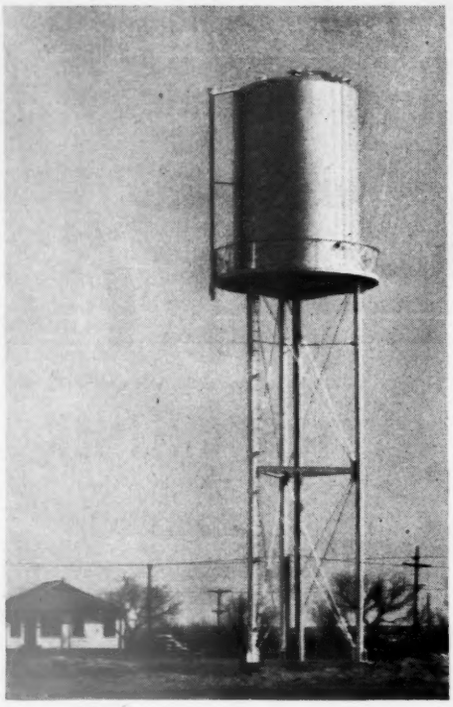
PARSONS HEAVY DUTY KOEHRING PRODUCT

PARSONS Trenchliners®

KOEHRING SUBSIDIARY

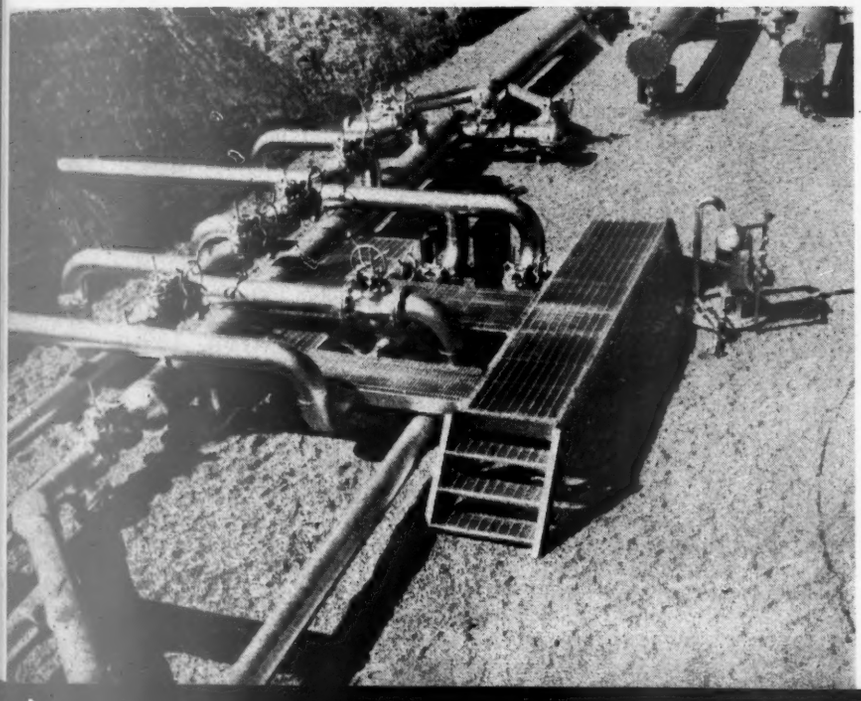
PICTORIAL

Right, on a job near Zanesville, Ohio, Williams Brothers Corporation, Tulsa, is using a Lorain "Pipeliner" hoe.



A 20,000-gal elevated water tank, 40-ft to balcony, built by Chicago Bridge and Iron Company, and installed at the Snyder, Texas, station of Lone Star Gas Company. The structure has three posts instead of the normal four-post tower.

Standing: J. H. Tice, left, Jones & Laughlin Steel Corporation; O. E. "Ted" Murrey, president, Midwestern Engine and Equipment Company; Roy "Fred" Parkhill; Roy F. Parkhill, president, Parkhill Truck Company; Scott Shore, Parkhill pilot, and R. W. Dense, Jones & Laughlin. Lee Williams, stringing foreman, kneeling. Picture taken at Newport, Arkansas, on Mississippi River Fuel Corporation job.



Richfield Oil Corporation's main header at Wheeler Station, California, with a Nordstrom valve-equipped manifold, is part of the newest link in the company's $7,000,000 pipe line project linking the valley area with Los Angeles. Spanning 112 miles of plains and mountain terrain, the 14-in. line roughly parallels a Richfield 125-mile, 10-in. line from Buena Vista Lake pump station, about 7 miles east of Taft. In the photo the pipe running into bank at left is 10-in. line from Lake Station. The pipe up from ground are 10-in. lines from Cuyama Valley.

Tom Billings, below, of Thornhill-Craver Company's pipe line sales department demonstrates to Ken V. Galt of the Neal & Massy Engineering Company the ease with which the 2-in. Unibolt hinged scraper trap operates. Galt, of Port of Spain, Trinidad, B.W.I., has been in the United States for the past two months visiting manufacturers that his company represents in Venezuela. These Unibolt scraper traps are being shipped to Venezuela to be installed on a pipe line now under construction.

Rocky hills, creeks and swamps, and numerous road crossings were only a few of the obstacles impeding work on Tennessee Gas Transmission's 24-in. line extending eastward from Buffalo. This is on H. C. Price Company's spread near Auburn, New York. Note the rip-rapping along the left side of this swampy right-of-way.

Snapped on Anderson Brothers Corporation spread working on Trunkline Gas Company system near Cleveland, Texas. J. Q. Goodwin, left, pipe inspector for Trunkline; L. J. Knox, Anderson superintendent; M. H. Waites, Trunkline engineer; E. L. "Jack" Henry, Trunkline chief inspector; R. C. Newsome, division engineer, Trunkline.

Caterpillar Diesel D8 tractors equipped with Trackson sidebooms laying a section of pipe on a Bechtel-Price-Conyes spread in California.

During a high flood stage of the Missouri River one of two lines on Shell's Ozark System parted near Weldon Springs, Missouri, necessitating some 200 ft of additional pipe. Here the pipe with weights attached is being lowered into place.

MINIMIZING PUMP STATION FIRE HAZARDS

Type of station construction now used in contrast to older installations—important factor; protective devices essential.

P. D. PHILLIPS and F. O. STIVERS

Abstract

This paper touches upon the hazards which result from a combination of heat and petroleum vapors in crude-oil and products pipe-line pumping-station installations. Sources of ignition are pointed out, but primary emphasis is placed upon the type of station construction now being used in pumping-station design in contrast to older installations. Equipment commonly used as protective devices is mentioned, and a summary of things which can be done to minimize pump-station fire hazards is included.

Fire can be either useful or destructive, depending on how it is used and what it is used for. So long as it is controlled by man, it serves him well and is a means toward progress; but out of man's control fire is an agent of destruction. Among the most common hazards to life and property are those of explosions, flash fires, and burning buildings. On the job and in the home, fire is an ever-present hazard to life and property. In many industries men must work with fire. As an agent in industrial processing and heating, they must contact it or be near it continually, thus placing themselves at its mercy unless it is controlled.

During the early years of the oil industry very little thought was given to the design of oil-field and oil pipe line equipment to reduce accidents and injuries. Likewise very little thought was given to the "layout" and "proper spacing" of pumping units, pump stations, tank farms, and utility equipment. For a long time the oil industry in general, including pipe lines, suffered severe losses that resulted from fire, explosions, and other accidents causing disability or death. With these losses repeated year after year, causing costly service interruptions and loss in property, the demand for economy and improved employee welfare required that they be reduced. In recent years the oil industry has led others in combatting these losses.

Much study and planning is being given by our engineers to the safe design of tools, equipment, pump stations, equipment and plant layout, and protective devices; and many ideas have been passed on to the designer and builders of this equipment. Today most of the manufactured oil-country equipment is safer, more efficient, and workwise than before.

Employees with long service in the petroleum industry have seen much done to make their jobs safer. Even though much old equipment is still in service, it has been re-arranged and made safer. Safety is given top priority by management and engineers when modern pipe line systems and stations are designed. Every worthwhile gadget and every control are usually "built in" or selected to prevent personal injuries and to protect property from fire and explosions. Every effort is made to achieve a plant layout that, within practical limits, will assure the safety of personnel and equipment, regardless of the mistakes made by people or mechanical failure of material.

In spite of the greatest precautions taken within industry, accidents continue to happen in which fire gets out of control and destroys life and property. It follows that all concerned should recognize these hazards and know how to prevent them and to protect themselves. The prime fact to remember is that fuel will not burn unless it is first heated; that fire can occur only when its three factors are present, viz.: fuel, oxygen, and ignition heat.

In our pipe line systems and stations, fuel is ever-present. The basic cause of most fires and explosions is the uncontrolled spillage or leakage of the crude or product being pumped, and this liberates considerable fuel, both liquid and gas. Oxygen exists wherever there is air, but heat exists only where it is generated. To a great extent, heat is controllable because it is the result of some physical or chemical action or of electricity.

Let us consider the sources of heat which may ignite fires in pumping stations.

Spontaneous Ignition

Some oils and compounds oxidize more rapidly than others when they are exposed to air. Linseed oil, used in paint, processes this characteristic. If a rag soaked with linseed oil is wadded up and left, oxidation takes place so rapidly that heat is generated. If this heat is not carried away by air, it soon reaches the kindling point, and spontaneous ignition results. Fire is started without the aid of exterior heat. Oil rags, iron sulfide, and certain acids in contact with combustible materials will self-generate enough heat to ignite.

Friction

Friction produces heat. Unless bearings in pumps and motors are thoroughly lubricated, friction will heat them. This heat may become so great that it will ignite combustible materials.

Ignition Out of Control

Gaseous fuels are easily ignited by a mere spark. In a gasoline engine the continued explosions that provide power are ignited by an electric spark—a controlled ignition. This same electric spark out of control will ignite flammable gases that have escaped into a room from leaky lines or open containers.

P. D. Phillips

F. O. Stivers

The Authors

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F. O. Stivers is assistant chief engineer of Humble Pipe Line Company. He received a BS degree in mechanical engineering from Purdue University in 1940. Before joining Humble in April, 1945, he was with the Southeastern Pipe Line Company and the Plantation Pipe Line. Prior to becoming assistant chief engineer, he was senior mechanical engineer for Humble.

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Likewise matches, which are perfectly harmless ignition agents when used for their intended purpose, become fire hazards when thrown out of control. Friction sparks caused by the contact of steel tools, pipe, and similar objects are believed to have caused many fires in the petroleum industry.

Direct Contact with a Blaze

Any open fire is a hazard to surrounding materials. Direct contact with an open flame such as a welding torch, blow torch, match, or the careless burning of trash is the quickest and surest way to start a fire.

Heating Equipment

Heating equipment—such as stoves, furnaces, boilers, radiators, steam lines, and similar equipment—is built to control the heat which is generated or conducted by it. However, the installers of such equipment and those who operate it often overlook the hazards which result from *overheating* and poor insulation. Thus an overheated stove or one set too close to flammable material is a fire hazard. The same principle applies to all electrical heating equipment.

Electricity

Overloaded electric wires, either in lighting or equipment circuits, can cause dangerous overheating and result in a fire. Sparks caused by open switches and other unprotected electrical devices frequently ignite combustible gases. The use of non-explosionproof electrical equipment in hazardous areas is dangerous.

Static Electricity

Modern pipe line pump stations are designed so that, in general, static electricity causes no trouble such as it does in plants where high-speed belts and other friction-creating materials are operated at high speeds. However, some thought should be given to the possibility of the generation of static electricity and the elimination of those things that could cause static charges to be accumulated, especially in dry climates. Opposite static charges are accumulated on objects insulated from one another and usually of different material; i.e., walking across a carpeted floor may cause the body to take one polarity of static charge while a metallic object on the wall may take the opposite charge and create a spark if such object should be touched by the person with the opposite charge. High-speed belts will create a static charge, but V-belts do not create so much static as do flat belts, which have a greater tendency to slip. Some V-belts are manufactured with a conducting ingredient molded into the rubber and fabric, and this is calculated to prevent the charge from accumulating on the belt and dissipating to some nearby object. In any event, nothing should be overlooked in the layout of a station to eliminate all probabilities of the generation of static.

Lightning

Lightning in some cases may create a considerable hazard, especially when burnouts of equipment in a station occur. Every precaution should be taken to prevent lightning from striking station equipment by:

1. Eliminating overhead lines that enter the station.
2. Bringing services in underground.
3. Placing surge arresters in switchgear where underground service enters.
4. Use of standard lightning arresters of the proper voltage at the substation or at the service end of the underground.
5. Use of repeater-type fuses with a small gap arrester connected between service wires and ground.

(The gap should be set at approximately 3/16 in. for 2400 volts; and, should lightning surges break across the gap, a fuse will blow and prevent the flow of power to ground. A gap of this length will limit the possible voltage to the underground cable to approximately 5000 volts.)

Communications circuits should also be protected with outside standard telephone "gap protectors," as well as with the fused-type protector in the office, which is considered not to contain a hazardous atmosphere. Wherever it is necessary to maintain telephone service in a hazardous atmosphere, the telephone signaling relay, hook switch, and any spark-creating apparatus incident thereto should be installed in explosionproof housings approved for use in such locations.

Flammable Liquids

In many instances flammable liquids are used as cleaning agents on tools and equipment, or are kept on hand as fuel for the operation of standby or emergency equipment. These should be stored in airtight containers and in a safe location.

It is the vapor from the flammable liquid that burns, and the ignition of that vapor is to be guarded against. The point at which the vapor ignites is known as the "flash point" of the liquid. It may be defined as that temperature at which the vapor arising from the liquid will ignite with a flash when a small flame is passed over the surface of the liquid. Gasoline has minimum flash point of minus 45 F; thus it will flash at normal atmospheric temperature as we know it. Most of the crude oils now being handled by pipe lines have a somewhat higher flash point than gasoline. However, they are highly flammable, and will usually flash at atmospheric temperature if a source of ignition is present.

Vapor not only accumulates over the liquid, but will spread rapidly and soon will tend to fill any closed space. When this occurs, saturated air, fuel, and oxygen exist ready for ignition. Any open flame such as a lighted match, burning cigarette, pipe, blow torch, welding torch, cigarette lighter, or open stove, will ignite the mixture and cause an explosion and fire. A spark from an open electric switch, telephone relay, poor wiring, or other defective electrical equipment may set off the mixture. Also heat generated by friction, such as an overheated bearing or sparks caused by striking iron on iron and iron on concrete or stone, may ignite the combustible mixture.

In the design and construction of our present-day pipe line systems and stations every effort is made to eliminate or minimize fire and explosion hazards. This is done by the proper selection of equipment and materials for the job at hand. Many different approaches are made and means used to accomplish the same end, viz.: safe operating conditions.

With the improvements that have been made in welding techniques and materials, today our above-ground line installations are far safer than the old screw-type lines. Piping installations, including complex manifold arrangements, can be made with fewer potential leaks than could be accomplished several years ago.

Station buildings are usually constructed of steel and masonry. No flammable materials are used in the finished construction except paint. Considerable thought and study are given to the layout of the plant as a whole, to the spacing and location of the equipment within the building, and to proper ventilation and normal movement of air currents through the pump building so that no dead spaces or areas will exist that would permit the accumulation of hydrocarbon vapors or gases. Normally the pump room, in which there is always a certain leakage of gas, is separated from the rest of the building by means of a gastight wall. Where there is a possibility that flammable gases may exist, explosionproof light fixtures, switches, heating systems, and wiring circuits are used.

Apparently in today's pipe line pump station construction the tendency is to get away from open conduits and pits, which were so common in the older stations. Not only do they provide an ideal place for the accumulation of gas, but they are very difficult to keep clean, particularly during the "bug" seasons. There is much difference of opinion as to the use of floor drains in pump rooms.

In recent years pumping stations have been constructed in which the pumps and prime movers are located in a common room; others with the pumps and prime movers separated by a fire wall with both the pump and driver rooms closed; and others with the pumps more or less in the open with a roof over them and with the drivers being installed in a closed room. In all, special attention was given to the proper ventilation of the installation at hand.

The most practical approach to the proper ventilation of a station building of the type recently constructed by the Basin, Ozark, Magnolia, Texas, Shell, Plantation, and Humble pipe line companies, and others is to install exhaust fans in the pump room and blower fans

to serve the other rooms. Thus, under any normal situation, there would be sufficient air-pressure differential to cause the movement of air from all non-hazardous parts of the building toward the pump room. This will tend to prevent the accumulation of gas in the so-called "safe portion" of the building, in which are situated open electrical and communication equipment and where smoking is permitted.

As dictated by the overall economies of the situation, standard open-type induction motors, forced draft jacketed open-type motors, and explosionproof motors have been selected as drivers for centrifugal pumps, with various types of installations being made as mentioned previously. When internal-combustion engines are used as prime movers, the normal practice appears to be to separate the engine from the speed-increaser and pumps by a fire wall, although in some instances they have been installed in a common room.

Numerous automatic safety devices and controls are available, and are used to provide protection to and proper operation of individual pieces of equipment, as well as to the plant as a whole. These include:

1. Emergency "stop" switches, which will permit the shutting down of a station without the necessity of someone having to enter the buildings.
2. Overload relays to protect motors and other electrical equipment from being overloaded and then overheated.
3. Temperature indicators, which will automatically sound a warning or shut the equipment down in case of hot bearings.
4. Combustible gas alarm, which will sound an alarm when 20, 40, or 60 per cent of the lower explosive limit is reached.
5. Mercoid controls to provide protection to lines and equipment against any low pressure.
6. And many others.

In the older stations everything was done manually—the hard way—with the operator handling all details. Some stations have been constructed that are fully automatic, with mechanical or electrical controls handling everything, including starting, stopping, and regulating. The operator, if one is provided, merely needs to look on and stand fire guard. The present trend in station construction appears to combine the best features of the manual and automatic stations.

Fire hazards in tank farms have been minimized by the use of steel roofs on the large storage tanks in lieu of the old composition and wooden roofs that were originally used. Also the use of floating or pontoon roofs, which were originally developed as a conservation measure, have considerably reduced the hazards of tank-farm fires.

Along with the improvements in station design and equipment, fire-protection equipment has also improved. Our most common pipe line fires are class "B" and "C" fires, and the present dry chemical fire extinguishers on the market are ideal for these types of fires. These extinguishers carry "B" and "C" Underwriters classification. In addition, there are other portable-type extinguishers such as carbon-dioxide "loaded-stream" extinguishers and foam extinguishers.

Permanent fire-protection installations can be made, as there are available carbon-dioxide systems, mechanical foam systems, and fog systems that can be used, provided there is sufficient water available. These systems can be installed to operate automatically or by manual start.

Last, but by no means least, good housekeeping is essential to good business and safe operation. By the proper training of the operating personnel in proper operating procedures and safe practices, order and cleanliness are promoted and accident and fire hazards are eliminated. As in the home, good housekeeping in a pump station is well summarized by the phrase "a place for everything and everything in its place." Management has the first responsibility in a good-housekeeping program to provide the proper place and the proper tools and equipment. This is essential to save time and effort, as well as to improve employee morale by developing in him pride in neat and orderly places of work. The cooperation of all concerned is required to promote safe and efficient working conditions.

Summary

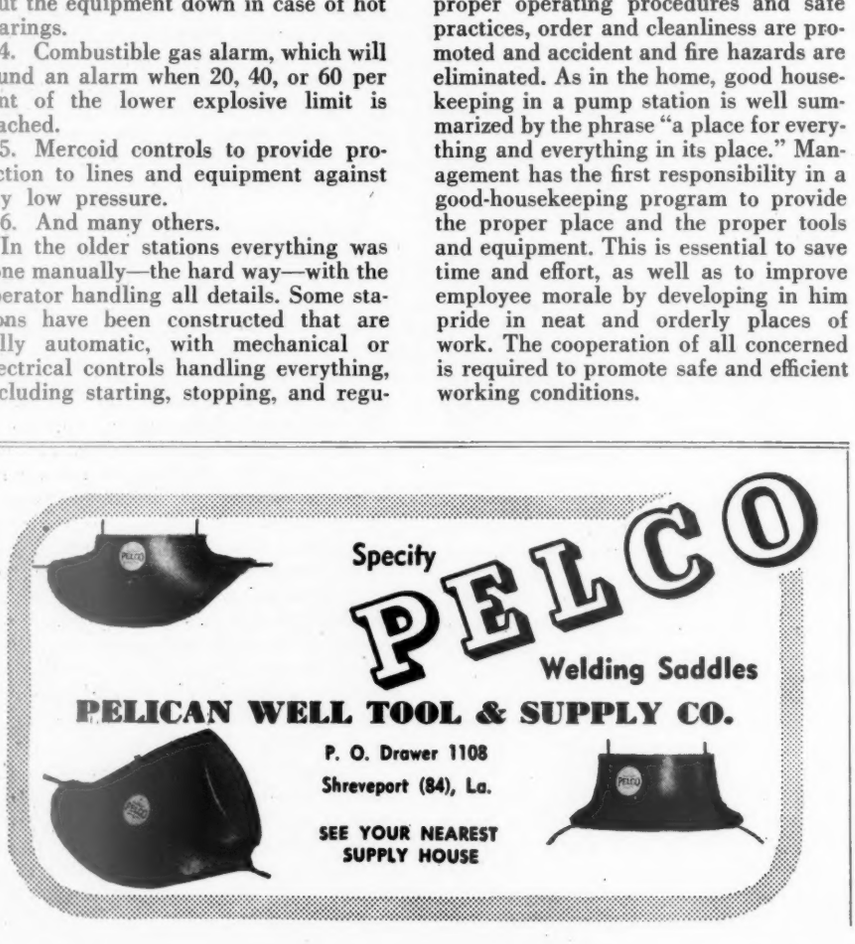
Now for a brief summary of things that can be done to minimize pump station fire hazards.

1. Proper selection and arrangement of equipment.
2. Strict adherence to pressure standards of main-line and service piping and fittings.
3. Special attention to ventilation of buildings.
4. Adherence to building and electrical codes applicable to hazardous installations.
5. Installation and MAINTENANCE of adequate grounds to all electrical equipment.
6. More use of high-pressure controls and relief valves.
7. Less open conduits and pits.
8. Use of radiant heating rather than direct heating.
9. More use of fire walls to separate pumps and prime movers.
10. Installation of pumping equipment in the open, particularly in those areas where general weather conditions will permit.
11. Use of more explosionproof electrical equipment and fixtures.
12. Use of velocity check valves in pressure-gage lines.
13. Use of air or electric remote-reading pressure and flow indicators.
14. Permanently installed and automatically operated fire-protection systems.
15. Shields provided on pipe flanges to prevent sprays in the event of a gasket failure.
16. Use of gas analyzers to check and warn of explosive mixtures of vapors and air.
17. Use of proper tools (non-sparking) during repair work.
18. Proper handling of sour crudes to minimize the formation of iron sulfide.
19. Training of operating personnel through:
    a. Safety rules and safe practices.
    b. Proper handling of equipment for routine operations and for possible EMERGENCY CONDITIONS.
20. Good housekeeping. * * *

Tennessee Gas Forms Five New Districts

Since completion of pipe line construction in New York state, five new districts have been organized by Tennessee Gas Transmission Company of Houston, Texas. Superintendent of Operations W. C. McGee, Jr., announces the following have been named superintendents in charge of these districts:

District No. 224, Finley Lake station site, Elwood Berry, superintendent; No. 229, Hamburg station site, L. W. A. Campbell, superintendent; No. 237, Clifton Springs station site, Elmo Stovall, superintendent; No. 245, West Winfield station site, Clarence Moore, superintendent, and No. 254, Nassau station, C. C. Overton, superintendent. Robert Stewart has been made superintendent, District 209, Cambridge, Ohio.



Pipe Line Construction Contracts*

Suggestions on what provisions a contract should contain are listed with a view to minimizing misunderstandings.

RICHARD A. GUMP

MEMBERS of the Pipe Line Contractors Association appreciate this opportunity to discuss construction contracts. Parenthetically it might be noted that the Pipe Line Contractors Association was organized in the fall of 1947 by a small group of contractors; its membership now consists of 42 leading contractors who construct practically all the cross-country oil, gas, and products pipe lines being built today. We have long wanted a chance to be heard by responsible officials of the pipe line companies. There are some members of our association who can recall when a pipe line contract consisted only of a letter stating the size of pipe, the depth of the ditch, and where the pipe line was to commence and end. Since that time the typical contract, with specifications and general conditions, has grown in some instances to a volume approximately 1 in. thick. We know that each oil company, its engineers and pipe line departments, kept adding paragraphs to the contracts and specifications in order to protect the company so that the pipe line might be completed by the contractor in a satisfactory and workmanlike manner.

The object of any contract should be to get a satisfactory pipe line constructed in accordance with the specifications at the agreed price. There should be no unreasonable or unfair provision in favor of either party. Actually there are relatively few provisions in most contracts, general conditions, or specifications with which fault can be found.

With few exceptions the relationship between pipe line companies and contractors is cordial. In most cases there is mutual trust and confidence, and most contractors feel that they will always receive fair treatment both in the general office and in the field, irrespective of contract provisions. The extensive pipe line construction program during the last 10 years, the development of specialized equipment for building these lines, the added skill and experience of the pipe line builders, the necessary growth that has taken place within the firms specializing in pipe line construction work in the last 10 to 30 years, and the entry of new firms into this specialized field, all have now made available a capacity for pipe line construction much greater than before, during, or immediately after World War II. The census of pipe line contractors made by the *Oil and Gas Journal* last year revealed that there are 142 pipe line contracting firms. These firms are able to place at the disposition of the pipe line companies 158 big-inch spreads, 341 trunk spreads, and 482 gathering-line spreads. The pipe line contractors have not only the organization, equipment, and experience available for large quantities of new construction, but also the ability to do work under the more rigid conditions and specifications that are called for today.

Our discussion of fixed-price construction contracts can best be divided into three sections, viz.: *A*, contracts and general conditions; *B*, specifications; and *C*, general remarks.

A. Contracts and General Conditions

It is not our purpose at this time to propose the adoption of a standard contract for use in pipe line construction. The Associated General Contractors of America, of which the Pipe Line Contractors Association is a part, has recommended and secured the adoption of a standard contract for building construction that is widely used throughout the United States. This standard form has been revised a number of times, and dates back some 15 to 20 years. However, we realize that the laws in different states and the varying opinions of your legal staffs make it impractical to urge the adoption of a uniform type of pipe line construction contract at this time. It does seem obvious to us, however, that the nearer it is possible to come to uniformity in the general provisions and conditions, the less chance there will be for misunderstandings or differences of opinion to arise. Fortunately most pipe line companies favor brief forms of contracts and general conditions with concise yet clearly written specifications. Nevertheless, some contracts consist of as many as 20 to 25 pages. We concede the right of every pipe line company to set conditions that it feels are for its own best interests; but, consistent with that right, mutually beneficial improvements are possible, and the suggestions we have to offer are made with this thought in mind.

In the preparation of contracts and general conditions, we offer these suggestions:

1. Make them brief. Although, of course, bids should not be calculated on the length of the contract, there is perhaps an understandable tendency to suspect a voluminous closely-written document that might contain unrecognized or ambiguous clauses which require an additional factor in the calculation. Brevity without clarity or completeness is a hazardous legal shortcut; but, assuming careful draftmanship, it is certainly true that the shorter the contract, the fewer the misunderstandings—before, during, and after performance.

2. Require high limits of liability and property damage insurance. This is protection both for the company and the contractor, and in this one respect there is a wide variation in the requirements of various companies. The added insurance limits are not expensive, and the present-day tendency toward higher and higher judgments by courts and juries

The Author

Richard A. Gump, executive secretary of the Pipe Line Contractors Association, was born November 22, 1917, in Tulsa, Oklahoma, and has been a resident of Dallas, Texas, since 1926. He received the degrees of bachelor of business administration and bachelor of laws at the University of Texas in 1940, and was a special agent for the Federal Bureau of Investigation, 1940–1945. He has engaged in general law practice in Dallas since 1945, and is a partner in the law firm of Goldberg, Fonville, Gump, and Strauss. Gump has been executive secretary of the Pipe Line Contractors Association since its formation in 1947. He is a member of the Dallas Bar Association, State Bar of Texas, Dallas Athletic Club, and Pi Kappa Alpha Fraternity.

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makes greater insurance protection a necessity. It is recognized that exposure to accidents and claims will vary greatly, depending upon the territory or area in which the work is done; but, if a great exposure is present on only a small section of the line, the insurance limits should be sufficiently high to give protection to the company and the contractor at that point. In this connection we believe it only fair that the contractor be permitted to place his insurance with a carrier of his own choosing. In most instances a contractor who has done business with an insurance carrier over a number of years would like to continue doing business with that same insurance company.

3. Indemnity and "hold harmless" clauses are generally included in construction contracts, but the many varied forms in current use reveal a confusion as to their purpose and justification. A part of this confusion probably arises by reason of the fact that some pipe line attorneys prescribe for their clients the last letter of "protection" without regard for the underlying policies. Stock-indemnity clauses designed for radically different situations are loosely borrowed and repeatedly applied to pipe line construction to the point where habit is mistaken for necessity. Some pipe line companies require the contractor to indemnify and hold them harmless from any loss whatsoever that arises from any causes growing out of or incident to the work to be performed, even to the extent of including claims resulting from the negligence of the pipe line company, its officers, agents, or employees. When an operation, such as pipe line construction, is undertaken for the joint benefit of the pipe line company and the contractor, there is no reason in fairness for the pipe line company to be indemnified against the results of its own negligence. Ordinary business policy would dictate that the person who causes a loss should pay for it; if both the pipe line company and the contractor cause a loss, both should be held proportionately responsible. If such responsibility was more clearly and fairly defined, the result would be that the cost of the construction would be ultimately reduced because of the fact that the contractor would not feel it necessary to include in his bid an additional compensation to protect him against some of the risks that he must now assume.

If indemnity and "hold harmless" clauses are to be used, we suggest that they embrace the following requirements:

a. Require the contractor to hold the owner harmless against liability in connection with any act of sole negligence on the part of the contractor or any of the contractor's employees.

b. In the case of concurring negligence, where both the owner and the contractor contributed to the act of negligence, the cost should be divided proportionately.

c. In cases where the act is the sole negligence of the owner, its agents or employees, the owner should be responsible for the loss.

d. Establishment in the contract of a time limit of one or two years on any loss for which the contractor might be held responsible.

e. Place the responsibility for furnishing pipe and other materials squarely on the owner company, and include specific provisions to compensate the contractor for relaying pipe in the event of loss by reason of line failure or other causes during pressure tests which result from faulty material furnished by the owner company.

f. The contractor should indemnify and hold the company harmless only against such damage or claims, together with costs, which arise or grow out of an injury to or death of persons, or damage to or destruction of property, which is caused by or which results from the contractor's operations under the contract.

4. The *force majeure* clause should be reasonable and equitable. It should provide that, if either the contractor or the company is unable to carry out its obligations under the contract because of *force majeure*, then, upon due notice in writing, such obligation shall be suspended during the continuance of such conditions.

The term "*force majeure*" should be clearly defined, and it should be definitely provided that the *force majeure* clause shall not affect other provisions of the contract relative to the payment by the company to the contractor for standby time or shutdown time.

At this point we should like to make a special plea for consideration of the risks to which a contractor is exposed in bidding jobs. If a contractor is delayed getting started on his work; or if, once started, there is a shutdown because of something beyond his control, such as failure of the company to obtain right-of-way or delivery of pipe and other materials on schedule, then he will be placed in a position from which he may find difficulty in extricating himself. It has happened that a contractor with work committed for his organization for a full construction season has refrained from bidding on any other work only to encounter during the season conditions over which he had no control, thus preventing his organization from performing any work whatsoever. We believe that any fair-minded person would agree that the contract should provide some protection for a contractor who finds himself confronted with such conditions.

5. Many, if not all, contracts provide that the contractor is an independent contractor and that the company is interested only in the results obtained. It should logically follow that the company is interested only in seeing that the pipe line is constructed in accordance with the specifications. Nowhere in the contract or specifications should there be any provisions contrary to this presumption. Likewise the company's officers, agents, and employees should treat the contractor, its agents and employees, as if the contractor were an independent contractor. There should be no authority given to the company or any of its personnel to issue instructions to anyone below the supervisory level. If an agent of the company has a complaint about the manner in which the work is done or the ability of a certain employee of the contractor, there should be no authority under the contract that would allow that agent of the company to take any action concerning such a complaint other than through the supervisory level of the contractor's organization.

6. There appears to be a trend of thought among some pipe line companies that in order to do a satisfactory job, contractors are able to lay only a certain amount of pipe daily. There are instances, under contracts that specify a rate of progress that the contractor should perform, where the agents of the company have interpreted such a provision as the maximum rate of progress that the contractor should be allowed to make. It should go without saying that such a provision or such a practice should not continue and, so long as the contractor is building the pipe line in accordance with the contract and specifications, nothing in the contract should be construed to limit his progress.

7. As stated elsewhere in this paper, many contracts and specifications set out thoroughly and elaborately the work that the contractor is required to do. In some contracts, however, there is a provision that the contractor shall be required to supply at this own expense any other work or materials not called for under the contract and specifications if these are necessary to construct a workable pipe line. This can be construed as

South Central Region NACE Members Meet

Members of the National Association of Corrosion Engineers from the states of Texas, Oklahoma, Colorado, and New Mexico, comprising the association's South Central Region, met October 18 and 19 at Corpus Christi, Texas, for the annual regional meeting. NACE members from other adjacent states also were in attendance.

The engineers also attended meetings of three of the association's technical committees on October 17.

The technical program included 12 papers on topics ranging from corrosion in chemical plants to corrosion on aluminum pipe lines. Two discussion periods also were held.

Social events included a luncheon October 18, a chartered boat ride on Nueces Bay, a seafood dinner and a sightseeing trip and barbecue on King Ranch on the morning of October 20.

The association, which has members in 46 states and many foreign countries, will hold its annual national conference and exhibition in Galveston, Texas, March 10-14, 1952.

a confession on the part of the company's engineering department that its specifications are defective. The only advantage of having such a provision in the contract would to be forewarn the contractor of impending bankruptcy, provided the company could ever take advantage of its literal import.

8. Whenever possible, the company should provide the contractor with sufficient information concerning the right-of-way and special right-of-way provisions so that the contractor will have knowledge of the conditions under which he may be forced to work at the time he submits his bid. In many instances all right-of-way has not been purchased by the time the contractors are requested to bid. In certain areas where the right-of-way is narrow (because of the very nature of the terrain and the ability of the company to obtain adequate right-of-way), it is almost impossible, as a practical matter, for the contractor to perform his work without getting off the right-of-way and causing damage for which he is responsible under the contract. Therefore, if the companies made a practice of providing this information to the contractor prior to the time his bid was submitted, such factors could then be taken into consideration.

9. The typical contract today has the provision that the contractor will be responsible for all work until it has been completed in its entirety and has finally been accepted by the company. It seems to us that a more fair and equitable provision would be that, when any severable and identifiable phase of the work has been inspected and approved by a company representative, that phase is no longer the contractor's responsibility. This is particularly true in the case of backfilling and cleanup work. On some lines, where the section of work that the contractor is building is 400 or 500 miles in length, it does not seem equitable that the contractor should remain responsible and take the risk of damage to the pipe line because of floods and washouts on sections of the pipe line that he has completed and which have passed inspection some time before. This actually is a maintenance job, and it is one responsibility that the company should assume at such time as that phase or part of the pipe line has been completed by the contractor.

B. Specifications

We stated previously that it was not the purpose of the Pipe Line Contractors Association to urge the adoption of a uniform type of contract at this time. However, we do believe that a great deal of progress can be achieved in standardizing specifications. As an example, for the past few years the Pipe Line Contractors Association has had a committee working with joint committees of the American Petroleum Institute and the American Gas Association in preparing a set of specifications for the field welding of pipe lines. A final draft of these specifications has been agreed upon by the joint committees, and has been or is to be submitted to these two organizations for approval. Already there are few substantial differences among the construction specifications of the various companies. The building of pipe lines has now come to an age where certain specifications could be standardized and accepted by all companies as approved methods of building efficient pipe lines. Consequently we feel that much could be accomplished through the appointment of other committees to standardize other phases of the work.

With the careful consideration that will come with the preparation and adoption of uniform specifications covering all phases of pipe line construction, any present tendency on the part of a few companies to issue specifications that are ambiguous, vague, or carelessly prepared will be done away with, thereby eliminating sources of possible misunderstanding and disagreement.

The Pipe Line Contractors Association stands ready at any time—and will welcome the opportunity—to meet with any committee or committees of the American Petroleum Institute in an effort to draft more uniform pipe line construction specifications.

C. General Remarks

There are a few suggestions of a general nature that we should like to offer in the promotion of better quality of work, lower costs, and better understanding and harmony of on-the-job representatives of the company and the contractor. By calling attention to these matters, we do not imply that they are directed toward all pipe line companies, or even that they are practical suggestions in every instance.

1. We suggest that, whenever a pipe line company makes changes in the form of its contract or in its general conditions or specifications, attention should be called to such changes in the invitation to bid sent out to contractors for the next few jobs. If a contractor has bid on work for a particular company over a period of years and has become thoroughly familiar with its general conditions and specifications, any changes that the company might make in such contract documents might escape the contractor's attention unless they are specifically pointed out to him. Some companies have adopted this practice recently, and it is believed that here again another source of misunderstanding can be successfully avoided.

2. Although this point is obvious to nearly everyone, it is of such importance that repetition will not serve to overemphasize its effect: Avoid construction programs during the winter and early spring in those parts of the country subject to heavy snowfall, rain, or spring thaws. Every experienced construction man is aware of the difficulties of trying to carry on pipe line construction work under extremely adverse weather and ground conditions. Not alone are the costs of doing work greatly increased, but at times it is almost impossible for the contractor to do a first-class job. After the construction has been completed under such conditions, an abnormal number of off-right-of-way and other claims ensue. Consequently, in addition to the increased construction difficulties and the added costs and claims, there develop impaired relations with landowners and tenants whose property has been crossed. We need not point out to this audience the importance of good public relations with the landowners and tenants.

3. We concede that delivery of materials and the acquisition of right-of-way complicate advance planning during these unsettled times, but there have been instances during these past few years when oil pipe line companies have benefited by awarding contracts on major projects well in advance of the commencement of construction and by having allowed a reasonable length of time for the construction work to be performed. In this connection it might be pointed out that most of the gas companies with cross-country systems can be commended for the foresight and advance planning that have gone into their construction programs, thereby making it possible to take maximum advantage of ground and weather conditions to carry out the actual construction of the pipe lines. We believe such advance planning will result in a saving to the companies by reason of lower bids and a higher quality of work.

4. One of the more vexing problems confronting both the companies and the contractors is the question of the testing of welders. We do not propose to be able to furnish an answer to this problem that will prove satisfactory in every respect. We do wish to point out, however, that the testing of welders is time-consuming and is a wasteful practice, even though it might have been necessary in the past and might continue to be necessary for some time in the future. We suggest that consideration be given to the establishment of more X-ray and visual inspection tests, as well as to some form of certification for a welder that will obviate the necessity of his being required to take two or three other tests on the same construction job merely because he may move or be moved from one part of the job to another. It is to be hoped that the method of testing of welders can be changed in such a way that it will be speeded up and made less costly both to the companies and to the contractors.

5. A number of companies have adopted the plan of requiring the company's inspectors and the contractor's superintendent and chief foreman to attend a prejob meeting at which they will discuss the job and make certain that there is mutual agreement and understanding of the specifications. We recommend this plan because we feel that it will result in better relations on the job, in the elimination of misunderstandings that might otherwise occur, and in the certainty that everyone is fa-

miliar with the specifications governing the work.

6. Many pipe line companies take great care in selecting personnel from among their permanent employees to act as inspectors on their construction work. The qualifications of each man, both from the standpoint of experience and personal characteristics, are usually taken into consideration—with the result that better on-the-job relations occur. The contractors, for their part, have during the past few years taken great care in selecting their own supervisory employees. In most instances today such supervisory employees of the contractor are employed on an annual basis, thereby making them more loyal and responsible persons—a desirable result both for the contractor and the company.

The end result of the benefits to be obtained in the careful selection of such inspectors and supervisory employees is that the inspection will be fair and reasonable — not capricious and arbitrary.

7. We fully recognize the right and desirability of each pipe line company to select its own list of approved contracting firms to bid on its work and, after receipt of such bids, the right and desirability of choosing one or more qualified firms to which the contract shall be awarded. On larger or on difficult and hazardous jobs, we particularly urge that great care be taken in selecting contractors; i.e., that careful consideration be given to the contractor's reputation, his experience on similar work, the availability of qualified personnel for supervision from within the contractor's own organization, the quality and quantity of the equipment owned by the contractor, and his financial responsibility. Although it may seem strange for an association of pipe line contractors to urge consideration of the foregoing factors when contracts are awarded for certain construction jobs, it is felt that failure on the part of one or more contractors to perform in accordance with their contract is a reflection upon the entire pipe line construction industry.

8. With the increasing use of underground high-pressure pipe lines for the transportation of highly flammable fluids and gases, and with many pipe lines passing through or near cities and industrial areas, continued attention will have to be given to the safety of each installation. We are aware of the fact that a bill has been introduced in the Congress of the United States which would give to the Federal Power Commission the right to prescribe certain safe practices in the construction of pipe lines—thereby, in effect, placing in the hands of the Federal Power Commission the right to prescribe specifications for pipe line construction. We, in the construction industry, feel that such an effort toward increased government regulation is undesirable. There is no question in our minds that the major operating oil and gas companies have personnel within their own organizations as well qualified to design safe installations as any which the government could employ. We, in the Pipe Line Contractors Association, stand ready at any time to do our part in assuring the construction of a safe pipe line in accordance with the specifications submitted to us by the pipe line companies.

It is our earnest desire that a reputation for skill, integrity, and responsibility be the goal of every member of the Pipe Line Contractors Association. We want to do our utmost to increase and promote high standards of efficiency in the construction of pipe lines. We believe that, through the medium of our association, we can accomplish such ends. We want to assure the pipe line companies that the contractors are ready to offer the facilities of our association and those of the individual members in any program that will contribute to the best interests of the oil and gas industry.

Summary

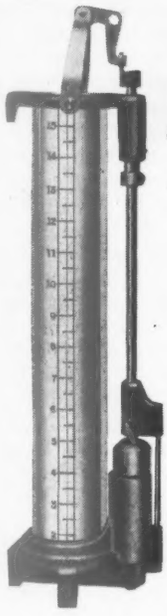
A. Introduction

1. The object of a pipe line construction contract should be the construction of a good pipe line in accordance with specifications at the agreed price.

2. As a result of the organizations, equipment, and experience of pipe line contractors today, large quantities of new construction can be undertaken.

B. Contracts and General Conditions

1. They should be brief.



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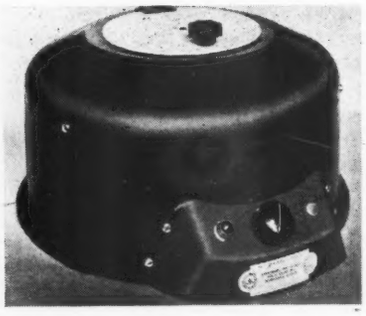

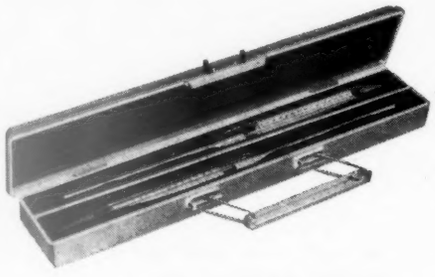

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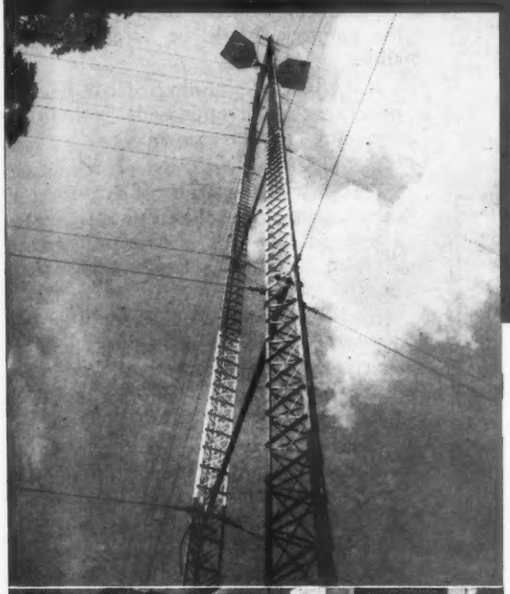

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2. High limits of liability and property-damage insurance should be required.

3. Fair and equitable indemnity and "hold harmless" clauses should be included in contracts.

4. Protection should be given to the contractor as well as the company under the *force majeure* clause.

5. The contractor's status as an independent contractor should be preserved and acknowledged not only in the contract, but also in actual practice.

6. So long as the contractor is building the pipe line in accordance with the contract and specifications, no limit should be placed on his daily production.

7. The provision in some contracts that requires the contractor to supply, at his own expense, any other work or materials not called for in the contract is not fair to the contractor.

8. Sufficient right-of-way information should be made available to the contractor at the earliest possible time in order that he may consider the difficulties that will be involved at the time he makes his bid.

9. The responsibility of the contractor for the work should be terminated when any severable and identifiable phase of the work has been inspected and approved.

C. Specifications

The adoption of uniform specifications, whenever practical and feasible, will result in increased understanding and less tendency to issue specifications that are ambiguous, vague, or carelessly prepared.

D. Remarks

1. Changes in the form of contracts used by each company should be called to the attention of the contractor to whom invitations to bid are forwarded.

2. Construction programs in the winter and early spring in certain parts of the country should be avoided, if possible.

3. Advance planning of construction programs is advantageous both to the company and the contractor.

4. The establishment of X-ray and visual inspection tests and a form of certification for welders might serve as a better method of testing welders and thereby eliminate unnecessary duplication of testing.

5. Prejob conferences should be held between company inspectors and the contractor's superintendent and chief foreman.

6. The selection of competent personnel as inspectors for the company and competent supervisory employees for the contractor would be desirable both for the contractor and the company.

7. Inspections should be fair and reasonable—not capricious and arbitrary.

8. Careful consideration should be given to the reputation, experience, availability of qualified supervisory personnel, quality and quantity of equip ment, and financial responsibility in selecting contractors on pipe line work.

* * *

R. P. White Named Somastic Manager by H. C. Price Co.

R. P. White, veteran Gulf Coast Somastic manager for the H. C. Price Company, has been named manager of the company's coating operations in the 37 states east of the Rocky Mountains, according to an announcement by J. S. Dewar, Somastic division vice president.

White's promotion followed the recent resignation of E. Rowland English, East Coast Somastic manager, who left the company for a position with another pipe coating firm.

Coincident with the promotion of White, the following changes in HCPCO's Somatic division were also announced by Dewar: Gulf Coast division —H. N. VerSoy named manager; Leo C. Carle, named assistant manager. East Coast division—Montie J. Lane named manager; Troy L. Huitt, named assistant manager, and C. V. Johnson placed in charge of sales.

White's career in Somastic, which began in 1940, was interrupted for several years by wartime duty in the navy. He has been in charge of Gulf Coast operations since a permanent Somastic plant was located at Harvey, Louisiana, in 1949. In his new position, White will operate out of Price's headquarters in Bartlesville.

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Automatic Gaging, Sampling, and Testing†

API committee studies extent to which automatic equipment is being used and its accuracy compared with manual methods

F. H. WARREN*

Introduction

During the last 12 months a subgroup of API Committee on Code 25—Measuring, Sampling, and Testing Crude Oil —has been investigating: 1, the extent to which automatic equipment is being used by the pipe line industry to measure and sample crude oil; 2, how the accuracy of this method compares with the presently approved manual methods; and, 3, whether the use of automatic and remote-reading equipment has sufficient general acceptance to warrant the preparation of a code of recommended practice governing its use.

The automatic devices in most general use are direct or remote-reading liquid-level gages, line samplers, and temperature-recording instruments. The use of positive-displacement meters for stock-control purposes is reported by some operators, but their use is limited, and only the first three types of equipment are discussed in this paper. Of 26 companies that have thus far replied to a committee questionnaire regarding the use of automatic equipment, 20 use remote-reading liquid-level gages, 10 use automatic line samplers, and 4 use automatic temperature-measuring devices.

Automatic Tank Gages

THE term "automatic tank gage" is applied generally to equipment comprising a gage line attached to a float in the tank, mechanical means of suspending the line in the tank, and bringing the free end down on the outside where it is carried on a reel at eye level. The reel is counterweighted to keep slack out of the line, and the assembly is mounted in a housing containing a window or "look box" through which the gager may read the oil height. The gage line is carried through steel conduit between the unit and the tank—thus making the equipment adaptable to gaging tanks containing liquids with high vapor pressure. There are several variations, but the foregoing description is typical of all automatic tank gages. Many of the automatic gages on the market are as accurate and reliable as hand gaging.

In order to produce a remote-reading liquid-level gage, it is necessary only to add to the direct-reading automatic gage electrical means of transmitting an impulse to a receiver placed at some convenient location.

The simplest type of remote-reading gage consists of two selsyn motors on which alternating-current voltage is impressed. One motor becomes the transmitter whose armature is positioned by a perforated gage line, and the other becomes the receiver. The two selsyn motors are interconnected electrically by five wires. The position of the armature of the receiving unit follows that of the transmitter instantaneously and, by a suitable gear train, indicates on dials the oil height in feet and inches. The selsyn motors make one revolution per foot of change in oil height. The two principal disadvantages of this type of unit are: (1) In case of power outage, the transmitter and receiver drop out of phase, and must be reset. (2) The units must be energized continuously, and this may cause overheating and high maintenance.

An improvement consists of a system using two selsyn motors in the transmitter and two in the receiver. One selsyn makes one revolution per foot of change in oil height, while the second is geared to make just under one revolution in the full tank height. The double selsyn units cost less on multiple-tank installations because only one receiver with selector switch is required for all tanks. Seven wires, plus one additional wire for each tank, are required to connect the various tank units with the receiver. Voltage is impressed on the system only when gage readings are being taken, and this results in low maintenance. The transmitters and receiver do not get out of phase with one another during power outages. Very satisfactory results are reported with this type of equipment.

Another type of unit on which good reports have been received consists of a transmitter having essentially two drums carrying contacts. One drum indicates the position of the oil height in inches and one-eighth inches, whereas the second drum indicates the oil height in feet. The receiver carries a series of numbers on a "lite-up" panel. One receiver with selector switch is used for multiple-tank installations. Thirty-nine wires, plus one additional wire for each tank, are required to connect the units.

Another interesting remote-reading gage uses the variable resistance of two precision-built potentiometers as a medium to transmit electrically the changes that are taking place in the oil height. One potentiometer line-drop rheostat, driven from a perforated gage line, makes one complete revolution per foot of change in oil height. A second potentiometer advances one position for each one foot of change in oil height. The two potentiometers of the transmitter are connected electrically to the receiver, which consists of one millivoltmeter graduated in inches and one-eighth inches; one millivoltmeter graduated in feet from 0 to 30; and a third graduated in feet from 30 to 60. A built-in selector switch permits using one receiver for multiple-tank installations. In addition, the receiver contains a rectifier unit to supply electronically-regulated direct-current voltage. A line-compensator rheostat is built into each transmitter in order to permit balancing the system and to obtain uniform readings from all tanks regardless of their distance from the receiver. Two common wires, plus two per tank, are required to connect the receiver with the various transmitters. The circuits are energized only when gage readings are being taken. The receiver will not go out of calibration when the a-c power source fails. One operator, after making a carefully conducted test from November, 1950, to March, 1951, in the Rocky Mountain area — comparing remote-reading electric gage readings with carefully taken hand gage readings and "look box" readings—is inclined to think that the readings taken by this gage were the more accurate. This operator has suggested that serious consideration be given to revising *Code 25* to sanction the use of automatic gage readings in connection with custody transfers, if agreeable to the parties concerned. Hand gaging of tanks containing crude with high concentrations of hydrogen sulfide is hazardous. In the worst cases some operators do not permit employees to descend into floating-roof tanks to gage, but, instead, lower the gage line from the platform at the top of the tank. Accurate hand gaging under such conditions is difficult, and the automatic direct-reading or remote-reading liquid-level gage appears to be the answer.

Automatic Samplers

Code 25 specifies that, when line samples are taken in connection with cus-

†Presented before the American Petroleum Institute, Division of Transportation, November 6, 1951, Chicago, Illinois, under the full title "Developments in Automatic Gaging, Sampling, and Testing Equipment."

*The Ohio Oil Company, Findlay.

tody transfers, the sampling tube shall be purged and a half-pint sample taken once each hour, or more frequently if necessary, to obtain a representative sample of the crude stream. The code also provides that automatic devices may be used to take samples if agreeable to the parties concerned.

The early automatic samplers were designed to duplicate as nearly as possible the hand procedure, and many of them are still in use. The timing is accomplished by a sequence timer, which more recently has been set to take either 4 to 12 samples per hour. A pressure-regulating valve has been added by some operators to maintain a constant pressure across the valve, regardless of line pressure. Mechanically, these samplers are quite reliable, and they require a minimum of maintenance.

In areas where crude is purchased on a gravity basis the tendency has been toward automatic samplers that maintain the sample under line pressure so as to eliminate the evaporation and loss of gravity experienced in hand sampling or the earlier types of automatic samplers. In this type of unit the mechanism employed for withdrawing the sample is essentially a small reciprocating pump with discharge-valve springs heavy enough so that line pressure will not force the unmetered sample through the pump. For all practical purposes, this type of unit may be referred to as a continuous sampler. A third type of unit, which bleeds a small continuous stream from the line, has been developed where the principal objective is to determine the gravity of the liquid. To the best of this author's knowledge, this type is not used in custody transfers.

Automatic samplers have not been universally accepted because of mechanical maintenance problems and the inability to obtain a true sample under all conditions, particularly when free water or high percentages of water and sediment are encountered. It is obvious, however, that the taking of ½-pint sample per hour manually and pouring it into a milk can with a not too tight-fitting cover does not give a representative sample either, except under most favorable conditions. We believe the problem will be solved by perfecting the automatic sampler. It is believed that eventually the preferred method of sampling will be by automatic means; but, until samplers are perfected, we believe no change need be made in *Code 25*.

Automatic Temperature Devices

Custody transfers of crude are made on a net volume basis, corrected to 60 F. *Code 25* requires that the oil temperature be determined by suspending a cup-case thermometer in the tank at specified heights for not less than 5 min, then withdrawing the thermometer, and immediately reading the temperature. Some operators report that their field gagers are instructed to leave the thermometer suspended in lease tanks at all times to overcome this problem.

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Tulsa Pipe Liners Club Elects Officers

The Tulsa Pipe Liners Club has elected new officers for the year 1951-52. F. C. Whiteside, chief engineer of the Continental Pipe Line Company, Ponca City, Oklahoma, is the new president.

Other officers are:

R. P. Lennart, supervisor of the oil-movements department, Service Pipe Line Company, Tulsa, vice president.

D. B. Good, assistant chief engineer, Texas-Empire Pipe Line Company and Kaw Pipe Line Company, Tulsa, secretary.

B. D. Leuty, special assistant to the manager of the crude oil supply and transportation division, Cities Service Oil Company, Bartlesville, treasurer.

A. H. Newberg, chief engineer of the Service Pipe Line Company, Tulsa, and J. D. Jones, assistant general superintendent of the Tulsa Pipe Line Division of Gulf Refining Company, were chosen new directors.

Other directors of the club are W. E. Biery, general superintendent of Mid-Continent Pipe Line Company, Tulsa, and P. L. Reichard, general superintendent, Tulsa Pipe Line Division of Gulf Refining Company.

ing, an error of 1 F will account for 34.0 bbl of crude. This compares with approximately 21 bbl resulting from an error of ⅛ in. in reading the oil height. The experience of The Ohio Oil Company indicates that errors of as much as 1 F in taking the oil temperature are not at all uncommon.

Many experimental installations of indicating and recording thermometers have been made. One method, which appears promising, is to suspend the bulb in the approximate center of the tank by means of a cable and pulleys so as to keep the bulb at the approximate center of the oil column. A variation of this scheme is to suspend the open end of a sampling tube at the approximate center of the volume of oil and pump oil out of the tube and back into the tank by means of a hand pump—observing the oil temperature indicated by an angle-stem thermometer installed in the line.

A more recent development is an averaging resistance-type thermometer. Certain metals have the property of changing their electrical resistance uniformly with a change of temperature. By measuring the voltage drop across the temperature element with a Wheatstone bridge, using a millivoltmeter calibrated in deg F, it is possible to obtain accurate temperature readings instantaneously. By making up varying lengths of temperature elements, ranging from a few feet to the depth of the tank, is is possible by using a selector switch to obtain the average temperature of oil of any section of the tank or for the entire tank. A standard resistor is built into the unit, and in order to test its accuracy, it is merely necessary to turn the selector switch to the "TEST" position. Extensive tests conducted by a major operator over several months demonstrate that this particular temperature device is ready for acceptance by the industry, and should be included as an acceptable procedure under the code.

Much work remains to be done by appropriate committees of the American Petroleum Institute in order to determine what types of automatic tank gages, line samplers, and temperature-measuring devices are worthy of code endorsement. In the interim the development of automatic equipment is well advanced, and its use should be encouraged by including a provision in *Code 25* permitting the use of automatic devices, provided all parties to the transaction agree to such use.

Acknowledgment

The author wishes to acknowledge the valuable information submitted by members of his able committee who made this paper possible. They include J. H. Field, G. R. Lake, J. H. McClintock, A. H. Newburg, R. C. Nicholson, H. C. Packard, R. K. Paine, W. E. Soden, and Joseph Zaba. * * *

Gas Sales Gain

Gas sales in August, 1951, totaled 3255 million therms, an increase of 16.1 per cent over 2803 million therms sold in August, 1950, the American Gas Association reports. The association's index of total gas utility sales for the month of August was 317.5 per cent of the 1935-1939 average.

During the 12 months ended August 31, 1951, utility sales of gas rose to 46,104 million therms, an advance of 15 per cent over 40,103 million therms sold in the comparable period a year earlier.

Natural gas sales for the month of August aggregated 3054 million therms, a gain of 17.1 per cent over 2609 million therms sold in August, 1950. The AGA index of natural gas sales was 343.5 per cent of the 1935-1939 average in August, 1951. For the 12 months ended August 31, 1951, sales of natural gas totaled 42,680 million therms, a gain of 16.7 per cent over a year earlier.

Combined manufactured and mixed gas sales during August, 1951, were 200.6 million therms, a gain of 3 per cent, compared with sales of 194.8 million therms of these gases in August, 1950. The index of manufactured and mixed gas sales during August, 1951 was 147.5 per cent of the 1935-39 average. For the 12 months ended August 31, 1951, utility sales of manufactured and mixed gas were 3423 million therms, a loss of 3.2 per cent under 3537 million therms sold in the previous 12-month period. Changes in sales of the several types of gas reflect a large number of conversions to natural and mixed gases. Sales of mixed gas exceed sales of manufactured gas for the first time.

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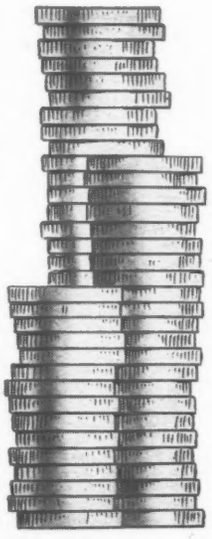

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NEWS

United Proposes Sale Of Pipe Line Properties

United Gas Corporation and its subsidiaries, United Gas Pipe Line Company and Union Producing Company, have filed an application with the Securities and Exchange Commission for approval of the proposed sale of various pipe line, producing, and distribution properties that these companies now operate in North Texas, announced M. A. Abernathy, vice president.

The proposed purchasers of the properties are Martin Wunderlich, of Omaha, Nebraska, and Lee Aikin, of Corpus Christi, Texas.

The proposed sale covers United Gas Corporation's natural gas distribution systems in 17 North Texas towns, United Gas Pipe Line Company's gathering and transmission lines in 15 counties in Texas and Oklahoma, and Union Producing Company's wells, lands, and leases in Wheeler and Young counties.

The application filed with SEC stated that United Gas desires to sell the properties for the reason that they are not connected with the main pipe line system operated by United Gas in other portions of the south and southwest, and are not capable of economic interconnection because of their location.

United Gas Pipe Line Company's properties covered by the sale will include approximately 640 miles of gathering and transmission lines.

West Central Texas Pipe Line Completed

A 10-in. pipe line outlet for crude production in Stonewall, Haskell, and Knox counties in west central Texas constructed by the Service Pipe Line Company has been completed.

Entering from Jud, in Haskell County, to Bowie, Montague County, the new 123-mile line traverses an area in which considerable exploration is underway. Pipe for the project was taken up from other parts of Service's 12,000-mile, 10-state system. Two new lateral lines to pools in Haskell County and Knox County are now being constructed.

F. M. Willenburg, Fort Worth, division manager, said the Jud-Bowie line has been connected to the company's trunk line system at its Bowie station.

J. L. Burke, Service Pipe Line president, announced plans for the line last April. It was built by Smith Contracting Corporation, Fort Worth, and O. R. Burden Construction Corporation, Tulsa and Wichita Falls.

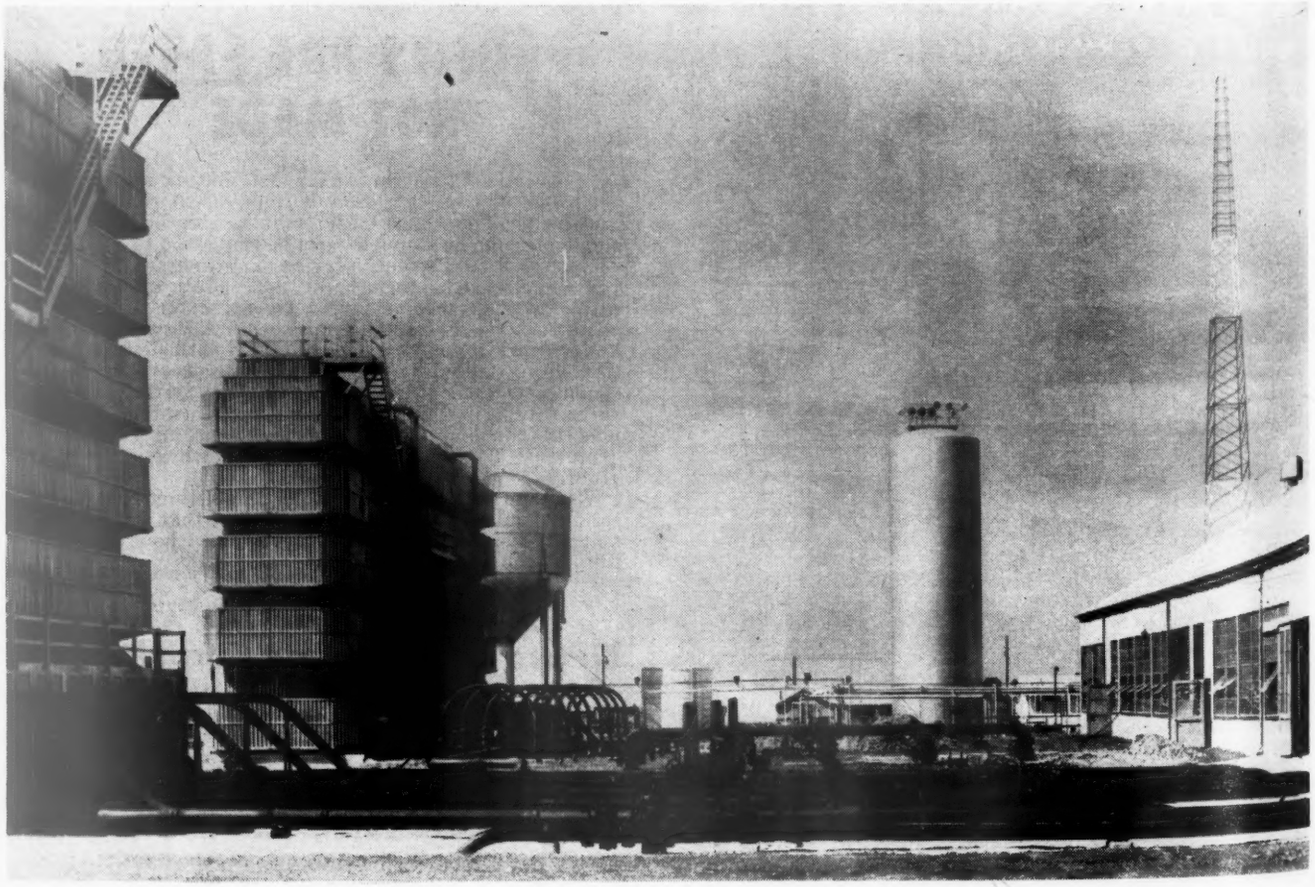
Cathodic Protection for Gas Compressor Station

The Harco Corporation announces the installation of a specially engineered cathodic protective system in a mid-western natural gas compressor station. Natural gas is received by the station through large diameter lines at approximately 400-psi pressure. In the compressor station (shown at right in photo), this natural gas is boosted to a 700-psi pressure and piped north and eastward for subsequent use, both domestically and industrially.

More than 45,000 sq ft of metal pipe surface is underground in this pressure boosting station to carry the gas to and from the compressors and water to the cooling towers (shown on left in photo). Estimated cost of this piping installation is more than $750,000. Soil conditions in this area are such that unprotected metallic pipe lasts on an average of from 9 to 11 years.

With the Harco-engineered cathodic protection system installed, the corrosion factor of the underground piping in this station has been virtually eliminated, and protection to the piping approaches 100 per cent. Total cost of the Harco installation was less than $15,000. In order to provide maximum protection for the piping, Harco engineers took into consideration soil conductivity, moisture content, soil and water chemical characteristics, temperatures, dissimilar metals, etc. Three electrode beds utilizing a total of 80 National Carbon graphite anodes were prepared, and National Carbon type BF-3 backfill material was specified. General Electric rectifiers delivering an estimated power output of 130 amp were installed. A direct current impressed on the anodes radiates through the backfill material and soil to the metal pipe surface to prevent electro-chemical action, which corrodes metals.

Cathodic protective system built by Harco Corporation in a natural gas company station.



Seven Transporters to Receive API Awards

Seven transporters who have contributed significantly to the work of the American Petroleum Institute in the field of transportation will be presented Certificates of Appreciation during the API's 31st Annual Meeting in Chicago, November 5-8, inclusive.

T. E. Swigart, of Shell Pipe Line Corporation, Houston, Texas, who is API vice president for the Division of Transportation, will present the awards to the seven men at a group session on Wednesday, November 7 in the Palmer House. Recipients of the citations are as follows:

Don A. Bering, deceased (formerly with Shell Oil Company, New York)—posthumous award for service as vice chairman and member of the Central Committee on Automotive Transportation; James J. Cosgrove (Continental Oil Company, Ponca City)—for service as chairman and member of the Committee on Valuation of Pipe Lines, and as a member of the General Committee of the Division of Transportation; Leo Huff (The Pure Oil Company, Chicago)—for service as chairman and member of the Central Committee on Automotive Transportation, and as a member of the Committee on Regulations; Ralph B. McLaughlin (The Texas Pipe Line Company, Houston)—for service as vice chairman and member of the Central Committee on Pipe Line Transportation, and as a member of the Committee on Valuation of Pipe Lines and the General Committee of the Division of Transportation; Frank W. Miller (Esso Shipping Company, New York)—for service as chairman, vice chairman, and member of the Subcommittee on Tanker Corrosion, and as a member of the Committee on Tank Vessels, the Subcommittee on Gas Hazards, and the Subcommittee on Oil Pollution; Edward D. Sheffe (Esso Standard Oil Company, New York)—for service as chairman and member of the Committee on Freight Classification, and as a member of the Committee on Railroad Transportation, the Committee on Car Service, and the Committee on Legal Subjects; Arthur O. Woll (General Petroleum Corporation, Terminal Island, California)—for service as vice chairman and member of the Subcommittee on Oil Pollution, and as a member of the Central Committee on Transportation by Water and the Subcommittee on Tanker Corrosion.

Half Billion Dollars for Underground Storage

The American gas industry will spend half a billion dollars in the next three years for development of underground gas storage fields, it was learned at the thirty-third annual convention of the American Gas Association in St. Louis, Missouri.

According to Fenton H. Finn, vice president of the New York State Natural Gas Corporation, Pittsburgh, Pennsylvania, one dollar of every five spent by gas utilities for plant improvement will go for underground "savings banks" to store natural gas near the big markets in the East, Midwest, and on the Pacific Coast.

"These fields make it possible for gas companies to meet peak winter demands, and to give better year-round service," Finn declared. "They are usually old, depleted gas and oil fields. When customer demand for house-heating mounts during cold weather, they can deliver rapidly out of storage huge quantities of gas to meet service peaks.

"The AGA estimates that about 350 billion cu ft of natural gas is now stored in this manner, an amount equal to about one-fourth of the annual residential gas consumption in the entire United States. The 'savings bank' system also keeps gas costs lower for consumers, since local utilities can buy the gas at a firm, year-round price, and conserve it until needed."

Costs of underground storage are very low, compared with those for above-ground tanks, additional storage pipe lines, or standby gas-making plants used for emergency gas supply, Finn pointed out. He is chairman of AGA's newly-formed Underground Storage Committee, which held its organizational meeting during the convention.

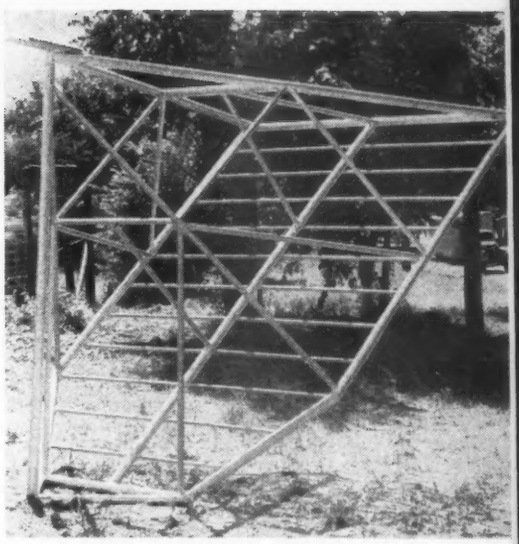
Searching for and rehabilitating gas storage fields is difficult, Finn declared, because certain underground geologic conditions are essential in order that the areas will hold the gas without losses, and will release it speedily when needed. There are now more than a hundred such fields in service, most of them having been developed in the last ten years.

"The search for storage fields is so extensive that in some cases, potential reservoirs in deep limestone and sandstone formations, which have never held gas or oil, are being tested for their usefulness as storage areas," Finn stated. The new Underground Storage Committee of AGA will compile storage records and disseminate information to the industry on the most advanced techniques of gas storage.

Microwave Reflectors For Pipe Line Use

New miracles are constantly being performed in the world of communications. One "miracle" that the oil industry is putting to advantage is the microwave radio display—used by pipe line companies that transport oil, gasoline, and gas through underground pipes over long distances. Instant microwave transmission of varying pipe line pressures at many points will facilitate the co-ordination of pumping equipment along thousand-mile pipe line systems.

Microwave radio relays will transmit as many as 14 messages on a single main signal. Essential for transmitting microwave signals, which, like light waves, travel only in straight lines, are a series of relay stations about 30 miles apart, each with towers 150 to 200 ft high.



Microwave reflector screens reflect incoming waves to repeater station.

The top of each tower carries two reflector screens of "mirrors," serving to reflect incoming waves to the relay or repeater station at the tower base, and to reflect the outgoing wave from the tower to the next relay station.

The aluminum reflector screen must be very accurately adjusted to assure perfect transmission. "Heliarc" welding proved to be the answer in the fabrication of reflector frames at Pioneer Iron Works, Sioux City, Iowa. "Heliarc" welding equipment was provided by Linde Air Products Company, a division of Union Carbide and Carbon Corporation. The reflector frame shown in the accompanying photograph is one of many being installed by the Tower Construction Company of Sioux City for use of an oil pipe line company.

Private Radio Telephone For Oil Pipe Line

The long lines department of the American Telephone and Telegraph Company has applied to the Federal Communications for authority to provide a private wire and VHF radio telephone system along a new oil pipe line between Lumberton, Mississippi, and Mobile, Alabama, operated by the Gulf Refining Company.

The pipe line requires eight intermediate heater stations and one intermediate heater and pumping station to move crude oil along the 88-mile route. Five of the stations will be connected by radio telephone to a base radio transmitter and receiver at Wiggins, Mississippi. The other four will be connected to a similar base station just outside Mobile. These base stations, in turn, will be joined to each other and to the pipe line terminals at Lumberton and Mobile by existing wire line facilities.

Service would be available at all points 24 hours daily.

Trunkline Gas Company System Officially Opened

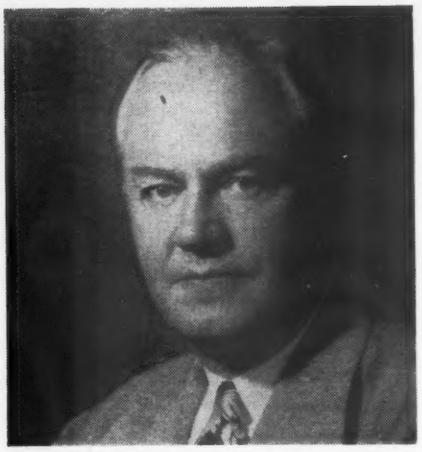
Ceremonies September 30 at Tuscola, Illinois, marked the official opening of the Trunkline Gas Company system, a month ahead of schedule. On that day gas was turned into the Panhandle Eastern Pipe Line Company system, parent company.

The 1300-mile line extends from the Louisiana and Texas gulf coast to Tuscola and delivers to Panhandle Eastern 250,000,000 cu ft of gas a day. From McAllen, Texas, to Lake Charles, Louisiana, the line is 24 in. in diameter, and from Lake Charles to Tuscola, 26 in. Four compressor stations have been installed, having a combined horsepower of 32,000.

R. S. Perry Elevated by Federal Telephone and Radio

The election of Raymond S. Perry as vice president and director of Federal Telephone and Radio Corporation, Clifton, New Jersey, manufacturing associate of the International Telephone and Telegraph Corporation, has been announced by William H. Harrison, president of I. T. & T. and Federal.

Perry, general sales manager of Federal's sales and commercial activities since 1949, has had wide experience in both the sales and engineering fields of the communications industry. As an executive and member of the board of directors of the Olin Industries, East Alton, Illinois, he directed the research activity for Western Cartridge, Winchester Repeating Arms, and other companies in the Olin Group. He also served as a vice president in charge of engineering and sales for the Ingersoll Milling Machine Company, Rockford, Illinois.



Raymond S. Perry

A graduate of the Massachusetts Institute of Technology, Perry represents Federal as a director on the board of the Radio and Television Manufacturers Association and is an executive representative for Federal with the National Electrical Manufacturers Association.

Best Annual Report Award Goes to Panhandle Eastern

In the final ratings of the independent board of judges in the Financial World Survey of Annual Reports the Panhandle Eastern Pipe Line Company was judged as having the best annual report of the pipe lines industry. The bronze "Oscar of Industry" trophy was presented to William G. Maguire, board chairman of the company, at the annual awards banquet in the Grand Ballroom of the Hotel Statler, New York, on October 29.

A total of 5000 annual reports were considered this year in the international competition, the eleventh in the series of surveys, and these were judged in one hundred industrial classifications for the "Best-of-Industry" awards. In the pipe lines industry Mississippi River Fuel was runner-up for top honors, with Tennessee Gas Transmission third.

The jury who made the final selections is headed by Dr. Carman Blough, research director of the American Institute of Accountants, and he was assisted by Dr. Pierre R. Bretey, president of the National Federation of Financial Analysts Societies and others.

Weston Smith, executive vice president and originator of the annual report surveys, presented the "Oscar of Industry" trophies at the annual awards banquet, which was attended by more than 1300 business and financial executives from the United States and Canada.

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Denies Rehearing On Phillips Ruling

The Federal Power Commission has denied five applications for rehearing of its opinion and order of August 22 in which it found that it does not have jurisdiction over Phillips Petroleum Company, of Bartlesville, Oklahoma, as a "natural-gas company" under the Natural Gas Act.

The applications for rehearing were filed by the City of Kansas City, Missouri; the City of Milwaukee, Wisconsin; the State of Wisconsin and the Public Service Commission of Wisconsin; the City of Detroit, Michigan; and the County of Wayne, Michigan.

The commission said that "No facts and no principles of law have been presented . . . which either were not fully considered by the commission before it entered such opinion and order, or, having now been considered, justify a reversal or modification of the commission's opinion and order."

FPC to Hold Hearing On Gas Allocation

A Federal Power Commission hearing will begin November 13 in Washington, D. C., on a petition by the Public Service Commission of Wisconsin requesting the FPC to order Michigan-Wisconsin Pipe Line Company, of Detroit, Michigan, to deliver the "proportionate and equitable" share of natural gas to which the state of Wisconsin is justly entitled.

The Wisconsin commission's petition alleges, among other things, that the company is proposing to allocate its supply of gas in an arbitrary and inequitable manner as between the public utilities that it serves in Michigan and those that it serves in Wisconsin.

The petition also asserts that the company has appropriated for the benefit of Michigan Consolidated Gas Company, an affiliate, also of Detroit, winter peak capacity and supply of gas, which it represented and designed to be available for the state of Wisconsin. The State Commission said that Michigan-Wisconsin permitted Michigan Consolidated to expand prematurely and inordinately its space-heating customers without consideration of Wisconsin and other pipe line customers, notwithstanding that Michigan-Wisconsin knew or should have known that Michigan Consolidated's expanded requirements could be met only by a continuation of its manufactured gas production or by drawing upon the equitable portion of the gas previously represented to be available to other markets, in particular those in Wisconsin.

The company, in its answer to the Wisconsin commission's petition, said that whereas it has not promulgated any plan of allocation among its customers, its presently authorized capacity will not permit the continued addition of space-heating and large industrial loads, and that it plans to so advise its customers.

The company further said that the peak-day demands of the Wisconsin customers depend to a large extent upon the continuation of the present restrictions upon additional space-heating and large industrial loads. Michigan-Wisconsin also said that its affiliate, Michigan Consolidated, has had a ban on space-heating conversions since May, 1950, and a complete ban on all additional space-heating loads since April of this year.

The Petroleum Administration for Defense's order No. 2 of last August 15, limiting additional space-heating and large industrial loads in several states, covered both Michigan and Wisconsin. The Wisconsin Public Service Commission later issued a similar order covering that State.

Contracting Officials Killed

Wayne D. Tiner and A. B. Knickerbocker, both officials of the H. B. Zachry Company, San Antonio, Texas, pipe line contractors, were killed in an automobile crash on the night of October 6 while returning home from the Oklahoma-Texas A. & M. football game at College Station. The accident occurred near Austin when another car attempting to pass them caused a three-way pileup with a truck. Also dead are Mrs. Knickerbocker and Mrs. Tiner. Their daughters, Susan Lane Tiner, 17, and Nancy Knickerbocker, 17, were injured. Tiner was president of Zachry company. Knickerbocker was superintendent of pipe line construction.

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PIPE LINE PERSONALS

J. H. Miracle, former secretary of the United Gas Corporation, Shreveport, Louisiana, has been elected a vice president, and **B. H. Winham,** assistant to the president, secretary. **N. C. McGowen,** United Gas president, announced the changes following a recent meeting of the firm's board of directors.

Miracle, a native of Arkansas, has worked in the oil and gas business for more than 30 years, and has been in the United Gas organization since December, 1931. He was elected secretary of United's subsidiaries in 1937 and became secretary of the corporation in 1946.

Winham, who is assistant secretary of two United subsidiaries, United Gas Pipe Line Company and Union Producing Company, joined the organization over 20 years ago, and was named assistant to the president in 1947.

Wilfred A. Colvin, formerly of Bowie, Texas, has been appointed industrial relations supervisor for the West Texas division of Service Pipe Line Company, **C. E. Wilson,** division manager, announces.

A native of Kansas, Colvin joined the pipe line company as a laborer in 1941. Promoted to division clerk in 1947, he was transferred to Bowie. Prior to his appointment as an industrial relations supervisor, he studied industrial relations in the company's general office at Tulsa.

The Service Pipe Line Company, maintains a division office in Lubbock and gathers approximately 150,000 bbl of crude oil a day from West Texas and New Mexico fields. This is transported by the company's Slaughter station-Drumright, Oklahoma, 16-in. pipe line to refining centers in the vicinity of Kansas City, St. Louis, and Chicago. About 200 persons are employed in the West Texas division.

C. J. Shulenberger, formerly of Topeka, Kansas, has been appointed industrial relations supervisor for the Missouri division of Service Pipe Line Company, **H. G. Mariner,** division manager, announces.

A native of Kansas, Shulenberger joined Service Pipe Line in 1937 as a laborer at Humboldt. Promoted to various posts, Shulenberger was transferred to Topeka in 1944 as a division warehouseman for Service.

Before assuming his new post, Shulenberger studied a course in industrial relations at the company's general headquarters in Tulsa. He and his family will make their home in Carrollton, Missouri.

Dick Stearns, head of the D. E. Stearns Company, Shreveport, Louisiana, makers of the Stearns Holiday Detector, is in Rio de Janeiro, having been called there by the critical illness of Mrs. Stearn's brother.

N. C. McGowen, president of the United Gas Companies, Shreveport, Louisiana, has announced a series of changes in the staff of the firms' legal department, including the appointment of a new general counsel and the assignment to a new post of the former general counsel.

W. O. Crain, who has served United in various legal capacities for the last 20 years, was appointed general counsel, succeeding **George D. Fisher,** who was named advisory attorney.

E. J. Freiberg, who has been associated with United since 1947, has been designated assistant to the general counsel to handle various legal matters relating to the financial phases of the companies' operations.

It was also announced that **Saunders Gregg,** formerly of Houston, Texas, has been made assistant to the general counsel in handling contract matters.

Crain, who is the son of the late W. O. Crain, general attorney for The Texas Company for many years, served United for the Houston law firm of Vinson, Elkins and Weems from 1931 until 1945, and then became directly affiliated with United Gas. He is a graduate of Rice Institute and obtained his law degree at University of Texas in 1931. Crain moved to Shreveport in 1936 and presently resides at 6330 Querbes drive.

Lee Thompson, research engineer for Lone Star Gas Company, Dallas, Texas, recently became chief engineer of the Michigan-Wisconsin Pipe Line Company. He has headquarters in Detroit.

Bernard S. Rodey, assistant secretary, Consolidated Edison Company of New York, Inc., was elected vice chairman of the accounting section of the American Gas Association at the thirty-third annual convention of the Association held in St. Louis, Missouri, October 15-17.

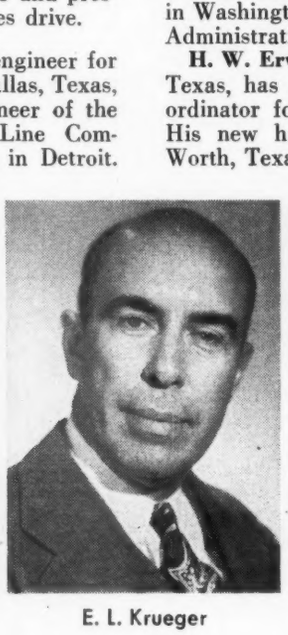
Rodey was educated in schools in Albuquerque, New Mexico, and attended Mercersburg Academy until 1909. He began his business career as lineman, foreman, and watch engineer for the South Puerto Rican Sugar Company in 1909 to 1911. He worked as construction foreman for the Puerto Rican Railway, Light and Transit Company, and as construction superintendent with the Insular Fair Board of Puerto Rico. He served with the United States Navy from 1913 to 1920, emerging with the rank of lieutenant (j.g.) and he held the rank of lieutenant commander in the Naval Reserve.

In 1921 he joined the predecessor company of Consolidated Edison and served as fixed capital engineer, assistant auditor, and auditor of the former New York Edison Company. When the company merged with Consolidated Edison in 1936, Rodey was made associate controller. He has been in charge of Consolidated Edison's tax department since 1946.

Emil Wienecke, Jr., administrative assistant to the vice president—traffic, Service Pipe Line Company, has taken a six-months' leave of absence to work in Washington, D. C., for the Petroleum Administration for Defense.

H. W. Erwin, division clerk, Tomball, Texas, has been promoted to area coordinator for the East Texas division. His new headquarters are in Fort Worth, Texas.

S. G. Loy



E. L. Krueger

Horace F. Taylor

S. G. Loy has been elected to the board of directors of Humble Pipe Line Company, replacing the late **L. E. Grissom,** it is announced by **O. Q. Lomax,** president of the company.

Other changes in the company's organization are the election of **E. L. Krueger** as secretary and assistant treasurer and **Horace F. Taylor** as assistant secretary. The latter office will be combined with the position of superintendent of oil movements.

Loy, comptroller of Humble Pipe Line Company since 1941, has been with the company since 1919. He was auditor from 1929 to 1941, when he was named assistant comptroller. He is a past president of the Houston chapter of the Comptrollers' Institute.

With the company since 1923, Krueger was made assistant to the treasurer in 1946. In 1949 he became assistant secretary and assistant treasurer.

Taylor spent 10 years in the field after his employment in 1933 as pipeliner and telegraph operator. He was assistant chief clerk and later chief clerk in crude oil dispatching.

R. V. Hanrahan, Retired Humble President, Dies

Ralph V. Hanrahan, 66, who retired last year after 25 years as president of the Humble Pipe Line Company, died October 11 in Houston, Texas. Hanrahan ended his active service October 10, 1950, after almost 49 years in the pipe line business. He joined Humble Pipe Line in 1919, and became vice president, general manager, and a member of the board of directors in 1920. He was named president in 1925. Under his direction Humble extended its system to 9000 miles of pipe lines.

R. V. Hanrahan

Hanrahan was born October 10, 1885, in Olean, New York. His family moved to Montpelier, Indiana, and it was there at the age of 15 that he went to work in a connection gang with the Indiana Pipe Line Company. Later he was put in charge of the main warehouse.

At the age of 19 he joined the Ohio Oil Company as paymaster on a pipe line project. For the next few years he worked on a variety of jobs in the middlewest, eventually becoming construction superintendent, and in 1909 he went with Standard Oil of Louisiana to assist in the construction of a trunk line to Baton Rouge. He joined Humble Pipe Line in Houston, March 8, 1919. His first assignment with this company was that of general superintendent, followed by promotions later mentioned.

He is survived by his widow; a daughter, Mrs. Henry Sauer, Houston; a brother, William G. Hanrahan, Dallas, and four grandchildren.

▸**G. H. Porch** was recently made superintendent of Lone Star Gas Company's X-ray plant at Gordon, Texas, succeeding **J. T. Hubbard,** retired. **William Chandler** has been named superintendent of the Cayuga compressor station, replacing Porch. The Waco station has been reopened with **P. J. Hurd** the superintendent. He has been succeeded by **T. B. Earnest** as Benjamin station superintendent.

▸**E. T. W. Hall,** Mid-Continent Pipe Line Company, recently became a member of The Pipe Liners Club of Tulsa. Other new members are **T. D. Castle** and **James C. Phelps** of the Service Pipe Line Company, and **James H. Buxton** and **Donald E. Anderson** of the Gulf Refining Company.

▸**L. J. Vandergrift,** vice president and general manager of the Southern Pipe Line Company, Lancaster, Pennsylvania, retired recently after serving 50 years with the company. He retains his status as a director. Succeeding him is **James T. Scally.**

▸**J. R. Mills, Jr.,** formerly of Tulsa, has been appointed industrial relations supervisor for the Kansas division of Service Pipe Line Company, **C. A. Childers,** division manager, announces. He will have his headquarters in Wichita, Kansas.

Mills' long record with the company, beginning in 1931 when he started as a welder at Seminole, has included several types of jobs. He has been welding inspector, division welder, and connection foreman in various parts of the company's 10-state system.

Following a period as supervisor of safety and industrial relations in Chicago, he returned to Tulsa, general headquarters of the company. Prior to his appointment to his new post he studied a refresher course in industrial relations at Tulsa. He and Mrs. Mills will live in Wichita.

▸**Eddie L. Smith** has been named assistant pipe line foreman at Pueblo, Ranger District, by Lone Star Gas Company. He succeeds **B. O. Flowers,** who died recently.

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Roskote's drying speed, its handling ease and its high electrical resistivity makes it the ideal mastic for pipeline protection, winter or summer. Whether you are protecting distribution and service lines, or large transmission lines in yard or field, it will pay you to investigate . . .

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Roskote's resin base resists acids, alkalies, salts and moisture. It bonds readily to previous coatings of coal tar or asphalt. Wire brushing is the only preparation needed for old pipe.

Roskote's drying speed and handling ease cuts man-hours from work schedules and speeds pipe-line progress. That saves real money! Yet Roskote costs only 3¢ per square foot of coverage.

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PIPE LINE PROJECTS

626-Mile Line Proposed To Import Canadian Gas

Glacier Gas Company, a Montana corporation, of Butte, Montana, has filed three applications with the Federal Power Commission in connection with a proposal to build a 626-mile pipe line system in the Pacific Northwest and to import natural gas from southwestern Alberta, in Canada.

The company, a wholly owned subsidiary of The Montana Power Company, also of Butte, plans to sell gas both at wholesale and retail in northwestern Montana, northern Idaho, and eastern Washington. The application did not give any estimate of the cost of the proposed project.

The project would include a main 20-in. line, 285 miles long, extending from the International Boundary, northeast of Kalispell, Montana, in a general southwest direction to Spokane, Washington. Another 120-mile, 16-in. line would extend southwest through Washington from a point near Spokane to Hanford, Washington. A 91-mile, 8⅝ in. line would run southeast from Spokane to Lewiston, Idaho, and a 130-mile, 12¾-in. line would extend north from Spokane to a point on the International Boundary south of Trail, British Columbia.

The company said the gas that it proposes to import will be produced in the Pincher Creek field, in southwestern Alberta. The company said that it has been informed that the gas reserves in that field are approximately one trillion, one hundred and seventy billion cu ft. The gas would be purchased from Westcoast Transmission Company, Ltd., at a point of connection on the International Boundary and gas would be redelivered to that company at the British Columbia treminus of the proposed line, Glacier stated. Westcoast Transmission is seeking authority from Alberta to expect a maximum of 25 billion cu ft of gas annually from the Pincher Creek field, Glacier said.

The three applications filed by Glacier are for authority to import natural gas, authority to construct and operate the pipe line system, and for a presidential permit covering importation of the gas.

Final Authority Given Michigan Gas Utilities

Michigan Gas Utilities Company has received final authorization from the Federal Power Commission for the construction and operation of approximately 77 miles of pipe line designed to transport natural gas to the Sturgis, Hillsdale, and Coldwater area of south central Michigan.

The pipe line system, which will have an ultimate daily delivery capacity of about 11,200,000 cu ft under design conditions, is estimated to cost approximately $1,500,000. Temporary authorization to construct the project was granted by the FPC on September 19, 1951.

The company plans to introduce natural gas for the first time to Bronson, Tekonsha, Union City, Jonesville, and Burr Oak, all in Michigan; and to convert existing propane air distribution system to natural gas in Coldwater, Sturgis, Hillsdale, and Quincy, all in Michigan.

The system will connect with Panhandle Eastern Pipe Line Company's facilities at a point south of Marshall, Michigan. The Commission recently directed Panhandle to deliver 5,000,000 cu ft of gas a day to Michigan Gas.

The application originally was filed by National Utilities Company of Michigan, of Battle Creek, Michigan, which subsequently changed its name to Michigan Gas Utilities Company.

Houston Pipe Line Is Expanding Its System

The Houston Pipe Line Company is engaged in an expansion program that will increase the capacity of its system to an estimated 500,000,000 to 600,000,000 cu ft of gas a day. The company is to lay 10 miles of 24-in. and 20 miles of 18-in. from its main 16-in. line west of Alvin, Texas, to Texas City. The completion date is set for March 1, 1952. Connecting to the western terminus of this line, 35 miles of 30-in. will be laid extending westward. This line is expected to be completed about April 15, 1952. On the western end of the 30-in. line a 12¾-in. line will be laid connecting into the Sugar Valley field, a distance of approximately 15 miles, and an 18-in. line connecting to the present 12¾-in. Boling line, a distance of 6 miles. The Boling line will be replaced with 18-in. pipe.

Recently the company signed a new contract to supply gas to the sulphur plant of the Jefferson Lake Sulphur Company at Clemens Dome, and will install 4½ miles of 8-in. from its 12¾-in. main line west of Freeport to serve this customer.

There is now being completed an 18-in. main line loop, 5 miles in length, from the Shell Refinery to the Crown Central Petroleum Company, in the Houston area.

In the North LaWard and Texana areas, and the Collier and Cordele areas north of Edna, all in Jackson County, 12¾-in. gathering lines are planned.

The cost of the extensions and improvements will be between $7,000,000 and $8,000,000.

1350-Mile Gas Line; Texas-to-West Virginia

Texas-Ohio Gas Company, of Houston, Texas, has asked the Federal Power Commission for authority to construct a 1350-mile natural gas transmission line extending from Texas into West Virginia.

The project, estimated to cost $184,989,683, would be constructed in two phases. The initial phase would carry about 330,000,000 cu ft of gas a day to West Virginia to be increased to about 505,000,000 cu ft a day in the second phase. An ultimate capacity of 650,000,00 cu ft daily is contemplated.

The proposed 30-in. transmission line would originate in Hidalgo County, Texas, near the Rio Grande River, and extend through Arkansas, Mississippi, Tennessee, and Kentucky, terminating near Spencer, West Virginia. The line would have 13 compressor stations with a total of 140,000 hp.

The company, which was organized last spring to construct and operate the project, said that it has assurance of acquiring natural gas reserves insuring the delivery of a minimum of 330,000,000 cu ft a day for 20 years, and that it is in position to acquire at an early date the additional reserves to increase this to 650,000,000 cu ft.

Time Extended for Completion of Merger

The Federal Power Commission has extended from 4 to 10 months the time for the completion of the merger of Canadian River Gas Company into Colorado Interstate Gas Company. Colorado's acquisition of the facilities of Canadian River was authorized by the FPC last February 28.

The two companies, both of Colorado Springs, Colorado, filed a joint motion last June seeking a modification of the FPC's February 28 order, to extend from four to eight months the time for completion of the merger. The extension was requested because of the length of time the matter had been pending before the Securities and Exchange Commission in connection with other aspects of the merger. The commission held a hearing September 26 on the matters and issues involved in the motion. During the course of the hearing, the companies requested that the period be extended to 10 months, which was done.

The commission's order denied a request by Natural Gas Pipeline Company of America, of Chicago, Illinois, to amend its petition to intervene in the proceedings, and that the FPC make certain specified modifications in its February 28 order.

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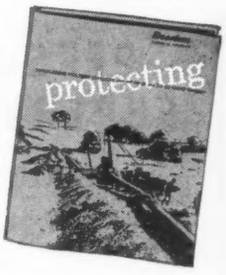

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Columbia Subsidiaries Get FPC Approval

Three subsidiaries of the Columbia Gas System, Inc., have received Federal Power Commission authorization to carry out the construction of natural gas transmission facilities, and the retirement of others, on their systems in Pennsylvania, West Virginia, Maryland, and New York.

The companies are The Manufacturers Light and Heat Company, Cumberland and Allegheny Gas Company, and Home Gas Company, all of Pittsburgh, Pennsylvania. Net cost of the entire project is $1,853,063 . . . or $1,052,911 for Manufacturers, $245,152 for Cumberland, and $555,000 for Home.

Manufacturers will construct a total of about 26 miles of line; retire about 18 miles of line; convert about 3 miles of transmission line to use as a distribution line, and retire a 125 hp compressor station. The facilities to be constructed and retired are in Fayette, Allegheny, Beaver, Somerset, Adams, Franklin, and Westmoreland counties, Pennsylvania, and Hancock County, West Virginia.

Cumberland will build about 13 miles of line, and retire approximately the same amount, in Preston and Barbour counties, West Virginia, and Allegany County, Maryland.

Home Gas Company will construct about 16 miles of line, to parallel an existing line, in Steuben and Chemung counties, New York.

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Intermediate Decision Omitted in Import Case

The Federal Power Commission has ordered the intermediate decision procedure omitted in the proceedings involving the proposal by The Montana Power Company, of Butte, Montana, to import natural gas from Canada.

The action, requested by the company, means that the case will be decided directly by the commission without the filing of an intermediate decision by the presiding examiner. FPC hearings on the company's proposal were concluded October 3 in Montana. Main briefs are to be filed November 1 and November 23, and Montana Power is to file its reply brief December 3.

Montana Power wants FPC authorization to import up to 10 billion cu ft of natural gas per year for five years for the exclusive use of Anaconda Copper Mining Company. The utility company also is seeking a presidential permit to cover the import of the gas. Removal of the gas has been authorized by the Province of Alberta for the five-year period ending April 6, 1956.

In requesting the omission of the intermediate decision, Montana Power said that because of the limitations upon the term of its permit from Alberta, any delay in beginning the importation will result in a reduction of the aggregate volume of gas that can be brought into the United States. The company also said that if it isn't given permission to import the gas, it will have to discontinue service to Anaconda, which it said is engaged in the production of minerals urgently needed for the nation's defense program.

Interprovincial Plans Further Expansion

Interprovincial Pipe Line Company plans to continue its expansion in 1952, T. S. Johnston, president of the company, announces. At the present time, Interprovincial is adding five pump stations to its system as well as building an additional 2,600,000 bbl of storage at Superior, Wisconsin, which will raise total available tankage at the terminal to 4,400,000 bbl. This work will be completed by the opening of navigation on the Great Lakes in 1952. The construction that is being done this year will provide ample capacity to take care of a peak summer movement out of Edmonton of about 113,000 bbl a day. With reduced pumpings during the closed season of navigation, the year-round average throughput will amount to approximately 100,000 bbl a day out of Edmonton.

In the first year of its operation, 1951, Interprovincial will deliver about 13,000,000 bbl of crude to Superior for tanker movement to the Ontario markets. In 1952 this will increase to about 18,000,000 bbl.

Commenting on the 1952 program of expansion, Johnston stated that plans provide for the looping of 100 miles of the 16-in. section of the system between Regina and the International border. One additional pump station will be added to the American section of the line at Deer River, Minnesota, and additional storage will be built at Superior to bring the total available tankage up to 7,000,000 bbl. The entire program is scheduled for completion by the time navigation begins in 1953.

The additions to Interprovincial's system contemplated in 1952 will increase the summer capacity from Edmonton the following year to a maximum potential of 146,000 bbl a day and 95,000 bbl a day into Superior. The quantity that will be delivered to Superior, however, is dependent upon the availabilitiy of tankers. This potential is somewhat in excess of today's tanker carrying capacity.

The construction programs for 1951 and 1952, outlined above, will be entirely financed from working capital and current earnings. In commenting on possible dividend policy for the company, Johnston stated that the board had decided to take no action at this time but may possibly consider a modest dividend program sometime during 1952. It is the feeling of the management that one year of full operation is necessary to appraise the company's earning ability.

Temporary Authorization Columbia Subsidiaries

Two subsidiaries of The Columbia Gas System, Inc., have received temporary authorization from the Federal Power Commission for the construction of natural gas pipe line facilities in Maryland, Pennsylvania, and West Virginia.

The companies are the Cumberland and Allegheny Gas Company and The Manufacturers Light and Heat Company, both of Pittsburgh, Pennsylvania. Total estimated cost of the construction is $2,191,237—$2,180,137 for Cumberland and $11,100 for Manufacturers Light and Heat.

Cumberland will build a 35-mile, 10-in. line from the Mountain Lake Park, Maryland, area to a connection with Manufacturers' system on the Pennsylvania-West Virginia state line in Monongalia County, West Virginia. Another 11 miles of line will be constructed by Cumberland in various sections of Garrett County, Maryland, and Preston County, West Virginia. An 880-hp compressor station will be built in Garrett County, and a 1200-hp unit will be constructed in Preston County. Cumberland also will convert a compressor station in Lewis County, West Virginia, to two-stage operation.

Manufacturers will construct about 100 ft of line in Fayette County, Pennsylvania, extending from the terminus of Cumberland's proposed 35-mile line to a connection with an existing line leading to Waynesburg, Pennsylvania. Manufacturers also will exchange a compressor cylinder at one of its stations for a similar cylinder at one of Cumberland's stations.

Lake Shore Authorization Affirmed by the FPC

The Federal Power Commission has affirmed, after a rehearing, its order of last February 15 authorizing Lake Shore Pipe Line Company, of Cleveland, Ohio, to acquire, construct, and operate pipe line facilities to supply the northeastern Ohio area with natural gas.

The rehearing, which was held earlier this summer, was concerned with a 27-mile section of old pipe line between Ashtabula and Fairport, Ohio, which Lake Shore will operate as part of its system after reconstructing a part of it. The FPC's February 15 order was conditioned to require, among other things, that the old pipe line be further tested.

The commission subsequently granted requests for rehearing by Erie Gas Service Company, Inc., and Grand River Gas Transmission Company, which were competing with Lake Shore for the northeastern Ohio market and whose applications were denied by the FPC's February 15 order. Erie and Grand River merged into one company, Grand River-Erie Gas Transmission Company, of Cleveland, prior to the rehearing.

In response to the commission's February order, Lake Shore conducted two tests on the section of old line, which the FPC said satisfied the conditions of the original authorization. Grand River-Erie had contended that the tests were inadequate.

The commission said that "we fail to find good cause to depart from our previous decision" authorizing the Lake Shore project.

Lake Shore's project, estimated to cost about $1,450,000, will include approximately 45 miles of 10¾-in. line extending northwest from a point of interconnection with Tennessee Gas Transmission Company's system near Meadville, Pennsylvania, to Ashtabula, Ohio, where it will connect with the 27-mile section of existing line, to be acquired from the Lake Shore Gas Company.

The FPC's order directs Lake Shore to commence construction of the project by September 1, 1952, and to complete it by December 31 of that year.

FPC Gives Permission For Illinois Gas Line

Union Gas and Electric Company, of Bloomington, Illinois, has been granted a certificate by the Federal Power Commission authorizing the construction and operation of a 33-mile natural gas pipe line in Illinois.

Union plans to serve customers in Bloomington, Normal, Farmer City, Le Roy, and Downs, all in Illinois.

The 8-in. line will extend from a point of connection with facilities of Texas Illinois Natural Gas Pipeline Company in Piatt County, Illinois, to a connection with Union's existing plant in Bloomington. The company also will build facilities necessary to serve customers in the area crossed by the line.

Construction Begins on Sarnia-Toronto Line

Construction work on the 64-mile Sarnia to London section of Imperial Oil's Sarnia-Toronto pipe line began the middle of October as huge mechanical ditch diggers began operations at a point just east of highway No. 21 near Wyoming, Ontario. Pipe has been strung along the right-of-way and the work crews will first proceed eastward to London and then link Sarnia and Wyoming. They will complete the section by December. The London-Toronto section and spur line to Hamilton will be laid next spring.

The line, which will carry gasoline, heating oil, and other petroleum products, is being built for Imperial Oil by Comstock Midwestern Limited of Leaside, Ontario. The first 132 miles of the line, from Sarnia to Waterdown, Ontario, will be of 12-in. pipe, the 56-mile Waterdown-Toronto section will be 10-in., and the spur from Waterdown to Hamilton will consist of two 6-in. lines.

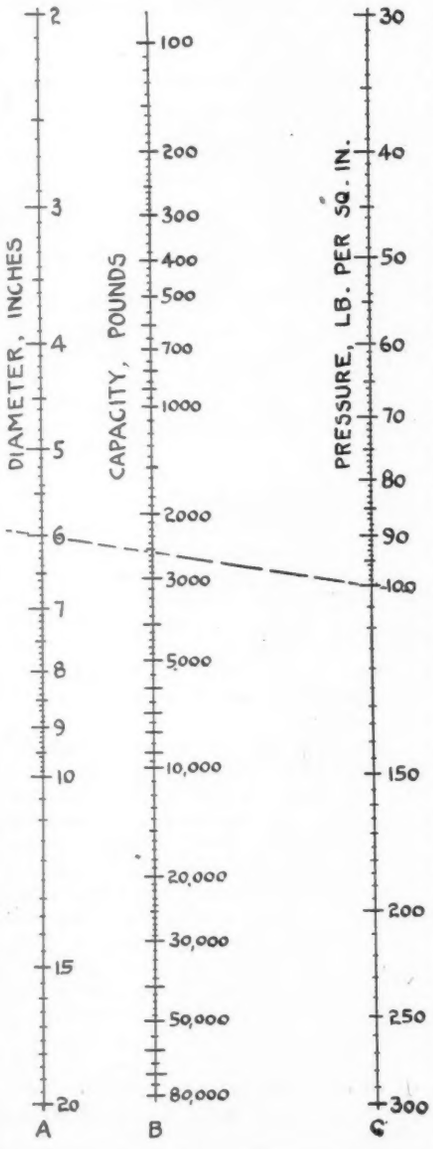
When completed the line will have an initial capacity of 39,000 bbl a day.

Hearing Scheduled on Transcontinental Request

The Federal Power Commission has scheduled a hearing to begin November 7 in Washington, D. C., on the application of Transcontinental Gas Pipe Line Corporation, of Houston, Texas, for authority to build a meter station near Williamston, South Carolina, for the sale and delivery of natural gas to the Duke Power Company, of Charlotte, North Carolina.

Transcontinental is proposing to sell up to 30,000,000 cu ft of gas per day on an interruptible basis to Duke. Estimated cost of meter station is $20,430, to be financed by funds on hand.

Determining Pressure on Piston and Cylinder Head



CYLINDERS and pistons in cylinders are used nearly everywhere in oil refineries and oil pumping plants.

As a result one of the most common problems confronting the petroleum engineer is that of determining the total pressure on a piston or on a cylinder head.

So, in an effort to be helpful, the writer has prepared the accompanying chart, which shows in an instant the total pressure that may be expected on the average piston or cylinder head.

For example, if the diameter of the piston is 6 in. and the pressure of the oil is 100 psi, the dotted line drawn across the chart shows that the total pressure is slightly over 2500 lb.

The chart is based on a transmission efficiency of 90 per cent, which is generally considered the "average." That is, the figures in column B are 10 per cent less than the "theoretical" figures usually given in tables.

In the event that the diameter of the cylinder is 60 in. instead of 6 in. the same dotted line gives the answer as 250,000 lb instead of 2500 lb. In other words, for each cipher added to the figure in column A, add two ciphers to the figures in column B.

Next let us suppose that the pressure is 1000 psi instead of 100 lb. The same dotted line then tells us that the capacity of the piston, or the pressure on that piston is 2,500,000 lb. You add one cipher for each cipher added in column C, and you add two ciphers for each cipher added in column A. In this last instance, therefore, assuming a diameter of 60 in., and a pressure of 1000 psi, it is necessary to add three ciphers to the figures in column B.

Finally, just for the sake of making things perfectly clear, let us say that the diameter of the piston is 600 in. and the pressure is 10,000 psi. What is the total pressure? The answer is, of course, 2,500,000,000 lb. All of which is "considerable pressure." ★ ★ ★

With the PIPE LINE CONTRACTORS

Oklahoma Contracting Company, 6512 Hines Boulevard, Dallas, Texas, completed during October its work on Northeastern Gas Transmission Company system in New England. Started during the month was 86 miles of 26-in. for United Gas Pipe Line Company from Pierce, Texas, southward. A field office has been opened at Edna, Texas, with M. E. "Panama" Shiflett in charge.

On the Texas Eastern Transmission Corporation system, a crossing of the Tennessee River is being made at Florence, Alabama. Paul Halbert and Aldress Kilgore are in charge.

Brown Lite Company, 135 North Sheridan Road, Tulsa, Oklahoma, is laying 102 miles of 8-in. between East St. Louis and East Chicago, on the Phillips Pipe Line Company system. The work is approximately 85 per cent completed. The following key personnel are in charge: R. E. Carriker, superintendent; Hedge Edmonds, superintendent; H. E. Lee, office manager; E. D. Sherburn, purchasing agent; H. B. Hoge, timekeeper; Lyle L. English, lowering-in foreman; John O. Moore, doping; Tillman Thomas, pipe; James F. Collier, welding; Bill Housman, right-of-way, and V. M. Rosson, ditch.

Sheehan Pipe Line Construction Company, 529 National Bank of Tulsa Building, Tulsa, Oklahoma, is laying 18½ miles of 16-in. pipe near Sugar Creek, Missouri, for Service Pipe Line Company. The pipe is Somastic coated. J. W. Brown is superintendent.

The contractor has recently completed taking up a gathering system near Reed City, Michigan, for the Anchor Gasoline Corporation, consisting of approximately 30 miles of various size pipe. C. M. Brown was in charge of the work.

Williams Brothers Company, National Bank of Tulsa Building, Tulsa, Oklahoma, is nearing completion of its work for Plantation Pipe Line Company. As originally contracted, this job consisted of 712 miles of 14 and 18-in. pipe line from Baton Rouge, Louisiana, to Charlotte, North Carolina, paralleling the company's existing system. Field offices on the windup are at Spartanburg, South Carolina, with T. E. Davis the superintendent, and at Gastonia, North Carolina, where A. T. Maxwell is superintendent.

For New York State Natural Gas Corporation, 78 miles of 20-in. pipe is being laid from South Bend, Pennsylvania, to Petersburg on the Pennsylvania-Ohio state line. The field office is at Mars, Pennsylvania. Clyde Gregory is superintendent and Walter B. Hammond office manager. This job is about completed also.

A total of 65 miles of 26-in. is being laid from Cleveland to Petersburg, Ohio, for the East Ohio Gas Company. The field office is at Ravenna, Ohio. O. R. Mitchell is superintendent and J. R. Purdy office manager.

The contractor's foreign division is going ahead with two jobs in Venezuela. For Shell Caribbean Petroleum Corporation, 160 miles of 30-in. is being laid from Palmerejo, near Maracaibo, to Punta Cardon. For the Venezuelan Atlantic Transmission Corporation, a 195-mile, 10, 12, and 16-in. pipe line is being laid from Las Mercedes to Caracas. Both jobs are under the supervision of Marvin Jones, who has his headquarters in Caracas.

L. E. Farley, Inc., 516 Chronicle Building, Houston, Texas, is constructing 64 miles of 10-in. pipe line between Eucutta and Lumberton, Mississippi, for the Gulf Oil Corporation. The field office is at Laurel. Glen Allman is superintendent and Wallace Campbell office manager.

Somerville Construction Company, Ada, Michigan, expects to complete by November 10, the 49 miles of 8-in. now being laid for Phillips Pipe Line Company between Farmer City and Piper City, Illinois. Work began October 15. Pete Hiner is superintendent, Harold Cook spreadman, and T. K. Murphy office manager.

Work got under way October 10 on 66 miles of 10-in. for Michigan Gas Utilities Company, between Marshall and Sturgis, Michigan. This job will be completed about November 30. Pat Mask is superintendent and Jim Godwin spreadman.

River Construction Corporation, P. O. Box 9127, Fort Worth, Texas, was scheduled to kick off November 1 on 90 miles of 20-in. for United Gas Pipe Line Company, from the vicinity of Orange, Texas, to Houston. The field office is at 3000 Commerce Street, Port Arthur. J. T. "Red" McMenamy will be spreadman and Q. B. Davis, Jr., office manager.

This contractor also is laying 212 miles of 20-in. and 43 miles of 24-in. for United from Napoleonville Junction, Louisiana, and Kosciusko, Mississippi. A spread under "Red" Tatom is laying 55 miles of 30-in. from the Mississippi River to the Louisiana-Mississippi state line. A. L. Price is manager of the field office, which is at Donaldsonville, Louisiana. Jim Reid's spread is laying 43 miles of 24-in. from Baxterville to McComb, Mississippi. Headquarters are at Columbia, Mississippi. Merle Tatom is in charge of the spread laying 40 miles of 30-in. from McComb to Livingston.

The crossings of the Pearl and Amite rivers have been completed.

Britton Contracting Company, Inc., 93 South Main Street, Washington, Pennsylvania, has completed the Home Gas Company job between Quackenbush and Horseheads, New York, and is on the last 20 miles for Manufacturers Light and Heat Company project. Overall, the latter consisted of 96 miles of pipe, 76 miles of 16-in. and 20 miles of 24-in. The 24-in. is now under construction. The field office is at Finleyville, Pennsylvania, with Fred McKenzie in charge.

Cheek Construction Company, P. O. Box 491, Ulysses, Kansas, is constructing a 101-mile gathering system near Ulysses in the Hugoton field for the Cities Service Gas Company. Pipe sizes are from 6 in. through 22 in.

Anderson Brothers Corporation, 707 North Drennan Street, Houston, Texas, has opened three field offices for construction of 90 miles of 14-in. pipe line for Gulf Oil Corporation between Lumberton, Mississippi, and Mobile, Alabama. One spread is working out of Lumberton, with Dick Leonard the superintendent. A second spread has its headquarters at Lucedale, Mississippi, with "Red" Williams the superintendent. D. C. Pope is superintendent of the spread that has its headquarters at Mobile, Alabama.

Two spreads are engaged on the Michigan Consolidated Gas Company's 121 miles of 24-in. from Big Rapid to Farmington, Michigan. Field offices are at Howell where L. J. Knox is in charge, and at Edmore where Frank Whitlow is superintendent.

The project office for the Algonquin Gas Transmission Company job is at Webster, Massachusetts. K. C. Smith is project manager. This job consists of approximately 100 miles of 24-in. pipe line from Hartford, Connecticut, to Boston, Massachusetts. "Rusty" Killingsworth is superintending the gang working out of Mendon, Massachusetts, and Russell McDowell is in charge of the office. At Mansfield Center, Connecticut, Earl Saulsman is the superintendent and Frank Hindman office manager.

Jim Rogers is now superintendent at Anahuac, Texas, in charge of laying 40 miles of 16-in. pipe from Texas City to Winnie, Texas, for the Pan American Gas Company.

Conyes Construction Corporation, 2884 San Pablo Avenue, San Pablo, California, is laying 117 miles of 22-in. pipe from Sheridan to Lima, Ohio, for the Ohio Oil Company. Jimmy Allman, Morris Norwood are spread foremen.

Pentzien, Inc., Omaha, Nebraska, is installing a crossing of the Ohio River for Texas Eastern Transmission Corporation on the Kentucky-Ohio border.

Comstock Midwestern, Ltd., Leaside, Ontario, Canada, is laying 64 miles of pipe line between Sarnia and London, Canada, for Imperial Oil, Ltd. This line should be completed by December. It is a part of the Sarnia-Toronto system. The section from London to Toronto will be laid next spring.

Gulf Southern Contractors, 516½ Louisiana Avenue, Shreveport, Louisiana, have the overall contract to lay approximately 1000 miles of pipe line for the United Gas Pipe Line Company in Louisiana, Texas, and Mississippi, including a marine line into the Gulf of Mexico, which has now been completed. Gulf Southern is a contracting group consisting of River Construction Corporation, Fort Worth, Texas; Oklahoma Contracting Company, Dallas, Texas; J. Ray McDermott and Company, New Orleans, Louisiana, and Morrison-Knudsen Company, Inc., Boise, Idaho.

Reese Brothers Construction Company, Hugoton, Kansas, is laying a gathering system for Northern Natural Gas Company, consisting of 181 miles of 4, 6, and 8-in. pipe, in Texas County, Oklahoma, and Kearny, Finney, Haskell, Seward, and Morton counties, Kansas.

Vaughn and Taylor Construction Company, Inc., Box 1351, Wichita Falls, Texas, is laying a gathering system in the Ulysses, Kansas, area for the Cities Service Gas Company, consisting of 179 miles of pipe in sizes ranging from 4 in. through 30 in. The field office is at Ulysses. D. D. Vaughn is superintendent and C. E. Sayles office manager.

Oman Construction Company, Inc., Box 146, Nashville, Tennessee, is laying 79½ miles of 30-in. pipe for Texas Eastern Transmission Corporation from Columbia, Kentucky, to Hartsville, Tennessee. The field office is at Columbia. W. M. Smith is superintendent, Floyd Hudnell spreadman, and T. J. Hopkins office manager.

J. L. Cox and Son, Raytown, Missouri, (stringing contractors), is stringing pipe between West Alton and St. Joseph, Missouri, on the Platte Pipe Line Company project. This job will total 280 miles of 20-in. pipe. Another section of the Platte has been contracted, 142 miles of 20-in. between Marysville, Kansas, and Holdrege, Nebraska, and this work will begin as soon as pipe is available.

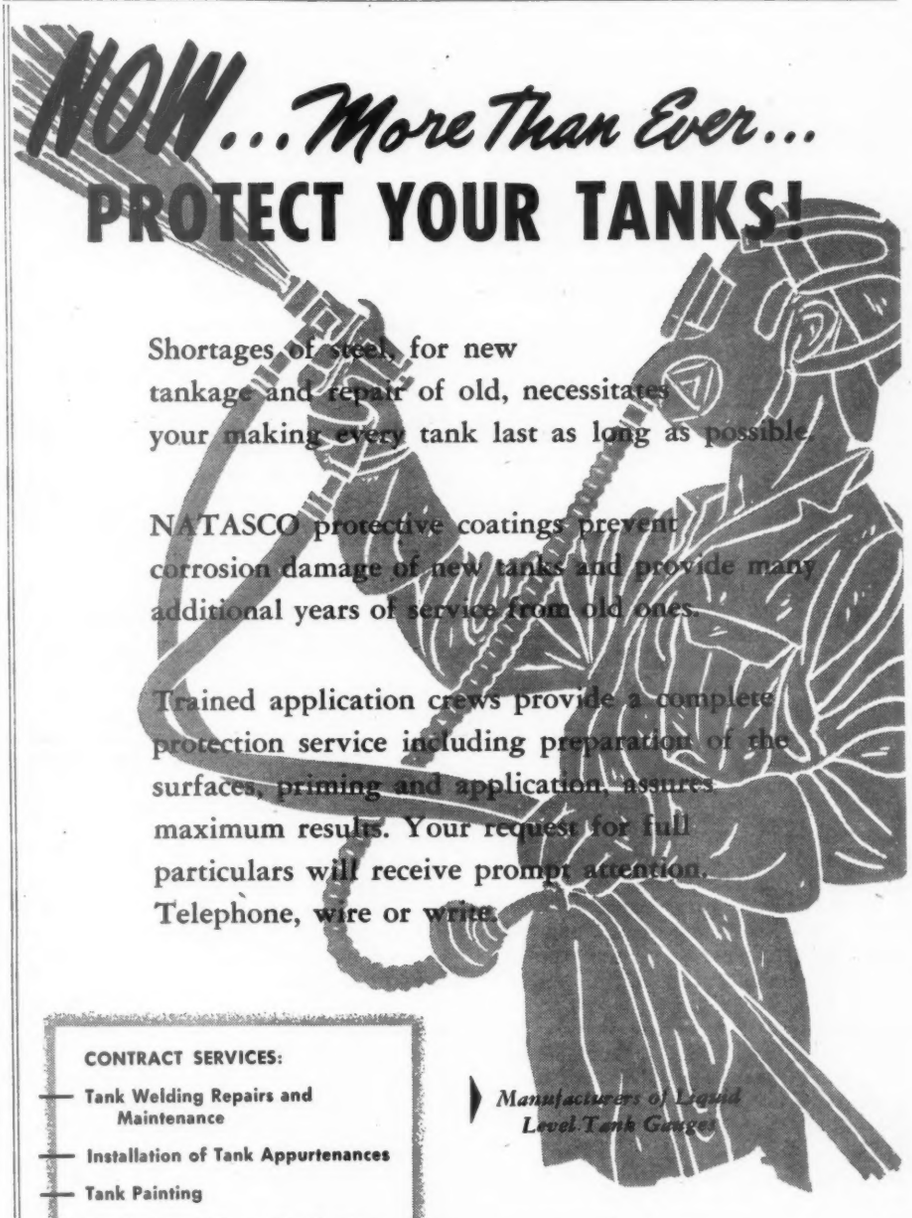
Work began the middle of October on 19 miles of 16-in. for Service Pipe Line Company, extending from the Outer Belt Road of Kansas City to Sugar Creek, Missouri.

O. R. Burden Construction Corporation, 6702 East 21st Street, Tulsa, Oklahoma, is constructing 280 miles of the Platte Pipe Line Company system, the section from the Missouri River near St. Joseph, Missouri, to Wood River, Illinois. The field office is at Mexico, Missouri. Barney Hall is superintendent and Howard Smith office manager.

Latex Construction Company of Georgia, Box 56, Northside Branch, Atlanta, Georgia, is doing the pump station and terminal work for Plantation Pipe Line Company on its expansion work now nearing completion. Buildings at seven stations are being enlarged to house additional pumping units on this products system, and terminals are being enlarged at all main points between Baton Rouge, Louisiana, and Charlotte, North Carolina.

Eastern Pipe Line Contractors, 1801 Mercantile Bank Building, Dallas, have been doing considerable right-of-way and ditching work the last month on the Texas Eastern job but little pipe laying. This was due to rocky terrain. With these obstacles more or less overcome, pipe is again going into the ground. Of the 76 miles to be laid between Florence, Alabama, and Columbia, Tennessee, 31 miles had been laid to October 19. The field office is at Lawrenceburg, Tennessee. Fred Byers is superintendent and J. W. "Dub" Arthur office manager.

Banister Construction, Ltd., 609 Northern Hardware Building, Edmonton, Alberta, Canada, kicked-off October 3 on 41 miles of 8-in. for The Texas Pipe Line Company between Wizard Lake and Edmonton. Eight miles had been completed by October 15, on which date a second spread was scheduled to get under way.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Ray L. Smith and Son, Inc., Hazlett Building, El Dorado, Kansas, has completed its work on the Texas Illinois Natural Gas Pipeline Company system, 58 miles of 20-in. from Joliet, Illinois, to the Volo meter station, except for line testing, which is now being done. Another job recently completed is the laying of 41,000 ft of 12-in. for the Commonwealth Natural Gas Corporation at Hopewell, Virginia, connecting to the Solvay Plant of the Allied Chemical and Dye Company.

Houston Contracting Company, 2707 Ferndale Place, Houston, Texas, has the following construction work under contract:

Approximately 181 miles of 26-in. gas line for Texas Gas Transmission Corporation from the vicinity of Bastrop, Louisiana, south to the vicinity of Eunice, Louisiana. This work is being done by three spreads located as follows:

North spread starting near Beekman, Louisiana, and laying approximately 65 miles south to the vicinity of Grayson, Louisiana. W. H. Hayes, superintendent; M. L. Thompson, assistant superintendent; J. C. Strickler and J. B. Stoddard, office; headquarters, Monroe, Louisiana. Approximately 22 miles completed early part October.

Center spread starting at header on the north side of the Red River near Pineville, Louisiana, and laying approximately 60 miles north to the vicinity of Grayson, Louisiana. E. C. Norris, superintendent; R. E. Thornton, assistant superintendent; R. J. Axsom, office; headquarters, Kingsville (Pineville), Louisiana. Approximately 18 miles completed.

South spread starting at header on south side of the Red River and laying approximately 56 miles south to Tepetate field near Eunice, Louisiana. F. A. Silar superintendent; C. V. Oliver, assistant superintendent; L. F. Redfearn, office; headquarters, Bunkie, Louisiana. Approximately 11 miles completed.

Approximately 140 miles of 12-in., 8-in. and 6-in. lay and take up for Interstate Oil Pipe Line Company in the vicinity of New Iberia and Frankling, Louisiana. H. L. Leake, superintendent; S. B. Harrison, assistant superintendent; H. C. MacWhinnie, office; headquarters, New Iberia, Louisiana. Approximately 115 miles completed.

Midwestern Constructors, Inc., 105 North Boulder, Tulsa, Oklahoma, has completed its work on the Texas Illinois Natural Gas Pipeline Company except for the Mississippi River crossing near Wittenburg, Missouri. Three 20-in. lines are being installed and this job is 65 per cent completed (October 16). The field office is at Grand Tower, Illinois. Howard S. Lipp is coordinator. Friday Davis superintendent in charge of pipe, and Ivan Steele office manager.

Work at Tuscola, Illinois, and Edgerton, Indiana, involving the installation of compressor units for Panhandle Eastern Pipe Line Company, is about 50 per cent completed. At Tuscola, F. C. Snavely is superintendent and H. H. Voss office manager. At Edgerton, K. L. Kreamalmyer is superintendent.

At Bauxite, Arkansas, a total of 28,800 ft of pipe is being laid for the Aluminum Ore Company. Earl Powell is in charge of construction with Morris D. Garey in the office.

H. B. Zachry Company, P. O. Box 2570, San Antonio 6, Texas, is finishing up 73 miles of 30-in. for Texas Eastern Transmission Corporation between Lebanon and Columbia, Tennessee. A. Vaughn is superintendent.

Additions are being made to compressor stations at Bushton, Mullinville, and Clifton, Kansas, for Northern Natural Gas Company. J. R. Johnson is general superintendent.

Trojan Construction Company, 1416½ North Robinson, Oklahoma City, Oklahoma, is laying 50 miles of 30-in. pipe between Ford and Moorhead, Kentucky, for the Texas Eastern Transmission Corporation. The field office is now at Mount Sterling, Kentucky. Charles T. "Swede" Tillotson is superintendent, Hubert Gragg spreadman, and Walter Wells office manager.

Smith Contracting Corporation, 205 Northwest Seventh Street, Fort Worth, Texas, completed the latter part of October its job for Service Pipe Line Company. This work consisted of laying 57 miles of 10-in. from the Salt Fork of the Brazos River near Throckmorton, Texas, to Humble's Jud station near Haskell. Herb Smith was superintendent, Jim McKnight spreadman, and John Briggs office manager.

N. A. Saigh Company, Inc., Suite 531 Majestic Building, San Antonio 5, Texas, is nearing completion of 80 miles of 30-in. for Texas Eastern Transmission Corporation, from Columbia, Tennessee, to Boonsboro, Kentucky. The field office is at Campbellsville. Carl Doyle is superintendent and Hubert Hutchins and Raymond Doyle assistant superintendents; James E. Gray, office manager; Jesse Cobb, chief inspector; Carl Avrett, welding foreman; J. N. Childress, doping; H. N. Russell, right-of-way; W. B. Uehling, stringing, and Charley Warren, pipe. James R. Scott is materials man.

Associated Pipe Line Contractors, Inc., 3272 Westheimer Road, Houston, Texas, has under construction approximately 100 miles of 20, 24, and 26-in. pipe line for United Gas Pipe Line Company. The section of line is from Napoleonville, Louisiana, to the Gulf of Mexico in the New Orleans area. The field office is at Morgan City. L. H. Gray is superintendent and Ralph Herwig office manager.

Some 40 miles of 24-in. double loop line is being laid in Louisiana and Mississippi for Southern Natural Gas Company. The field office is at Monroe, Louisiana. Wm. Briley is superintendent and James Luther office manager.

R. H. Fulton and Company, P. O. Box 1526, Lubbock, Texas, has moved its field office to Wheatland, Wyoming, on the Platte Pipe Line Company project. In all, this contractor will lay approximately half of the Platte system, the pipe being 16 and 20-in. A. A. Carrigan is superintendent and Dave Wagner office manager.

For Colorado Interstate Gas Company, 250 miles of 20-in., are being laid from Kit Carson, Colorado, to the Canadian River north of Amarillo, Texas.

For Panhandle Eastern Pipe Line Company, 124 miles of 20, 24, and 26-in. loops are being laid between Sneed, Texas, and Olpe, Kansas. The field office is at Ottawa, Kansas. M. L. Boyd is superintendent.

Western Pipe Line Constructors, Inc., Lockhart Building, Austin, Texas, has one spread working out of Richmond, Kentucky, on the Tennessee Gas Transmission Company line, and another out of Morehead. Both spreads are expected to complete their work about the first of November. Originally the job consisted of 121 miles of 30-in. between Parsons, Tennessee, and Salt Lick, Kentucky. W. B. Williams and Jack Hodges are the superintendents.

Mahoney Contracting Company, 2300 North Grand River, Lansing, Michigan, began pulling the Gulf of Coro crossing for Shell Caribbean Petroleum Company on October 13. This consists of a single 30-in. line 4 miles long. Upon completion of Coro, the Lake Maracaibo crossing will follow immediately, which will be two 20-in. lines each 5 miles long. Angelo Tavernaro is in charge of the jobs.

For Texas Eastern Transmission Corporation, 100 miles of 30-in. is being laid from the Kentucky River to the Ohio River. Barney Finnerty is in charge, with the field office at South Shore, Kentucky.

Work is underway on about 95 miles of loops for the Michigan Gas Storage Company. The pipe is of 8, 12, 16, 20, 22, and 24 in. diam, and is being laid between Laingsburg Junction, Mt. Clemens, and Pontiac, Michigan. The field office is at Rose Center, Michigan, with Henry Mogg the superintendent.

G. G. Griffis Construction Company, 2514½ East 15th Street, Tulsa, Oklahoma, has under construction for Northern Natural Gas Company, 210 miles of 26-in. loops in Kansas, Oklahoma, Texas, and Nebraska. A crossing of the Republican River, also is being made near Clyde, Kansas. The field office is at Concordia, Kansas, with G. L. Mims general superintendent, E. G. Grisham spreadman, and Mont Wood office manager.

Bishop and Lock Construction Company, 1018 Magnolia Building, Dallas, Texas, will lay 142 miles of the Platte Pipe Line Company system when pipe is available. The section is from Marysville, Kansas, to Holdrege, Nebraska.

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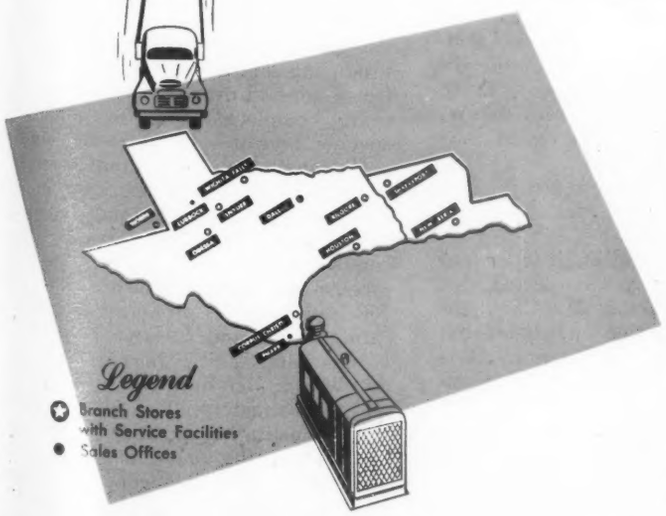

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NEWS

OPS to Adjust Some Crude Oil Ceiling Prices

The Office of Price Stabilization has taken action to permit adjustment of out of line ceiling prices on crude petroleum of comparable grades in fields or pools within the same producing area.

In a supplementary regulation to Ceiling Price Regulation 32, effective October 9, 1951, the agency has established a procedure for a purchaser or seller of crude petroleum, in oil fields or pools where some prices were frozen at sub-normal ceilings, to apply for adjustment of his ceiling price.

This action is not expected to affect consumer prices of petroleum. It was necessary, OPS said, because at the time of the general price freeze there were many fields or pools where prices were frozen at levels below the in-line ceiling price for the same general producing area.

If his ceiling price is below the in-line ceilings in the same general producing area, the purchaser or seller may make application for an adjustment of his ceiling price to Petroleum Branch, Transportation, Public Utilities and Fuels Division, OPS, Washington 25.

His statement must include his proposed new ceiling price; an explanation as to why he cannot price under existing provisions of CPR 32; a description of the available transportation facilities, the gravity, characteristics and source of the crude petroleum in question, and evidence that the adjusted ceiling price will be in line with that of comparable crude petroleum in the same general producing area.

OPS Raises Prices on Oil From Texas County Field

The Office of Price Stabilization has approved Arkansas-Louisiana Gas Company's application for an increase in the price of gas and liquids derived from the Waskom field of East Harrison County, Texas. The increase was made retroactive to December, 1950.

Under OPS approval, gas is now figured at 7 cents per 1000 cu ft at the well-head, figured on the new statutory basis; (2) a full one-eighth royalty is allowed for liquids extracted by normal separator processes at the well, and (3) royalty on liquids extracted at the firm's gasoline plant will be paid on a basis of one-eighth of the market value of the plant product, less 40 cents per barrel for plant charge.

The company has been paying 5 cents per 1000 ft at the well-head.

ASME Holds Annual Meeting

A record program has been planned by the American Society of Mechanical Engineers for its 1951 annual meeting in Atlantic City, New Jersey, November 26-30. Over 220 technical papers will be presented at more than 90 sessions to be sponsored by 34 professional divisions and committees of the society.

Ohio Oil Expansion Plans Soaring, Donnelly Reports

The Ohio Oil Company is spending a record-high $40,000,000 this year in expansion programs to help meet the nation's rapidly rising demand for petroleum, J. C. Donnell II, President, told members of the Cleveland Society of Security Analysts at a luncheon meeting recently.

Capital expenditures during the past five years have totaled $128,000,000 for new facilities in production, transportation, refining, and marketing. Funds for these programs have been provided entirely through capital extinguishments and earnings, he said, with no recourse to debt financing.

Ohio has acquired substantial acreage in the Williston Basin and has joined with a group to explore 9,000,000 acres in Saskatchewan, Canada.

The company is accelerating its exploration efforts in the Rocky Mountain region, and is preparing to drill a 20,000-ft test well in the Paloma field in California, he said. Experimental secondary recovery projects in the company's extensive acreage in old Illinois fields indicate that 60 to 70,000,000 additional barrels of oil may be recovered through extensive water-flooding of these fields. Similar projects are being conducted in Kansas and Oklahoma.

Donnell reviewed other Ohio Oil expansion programs, including the construction of a large natural gasoline plant in the North Markham and North Bay City fields in Texas. Designed to process 100,000,000 cu ft of natural gas per day, the plant will be operated by The Ohio under a unitization agreement with another company.

Work has begun on the final section of the company's "big inch" crude oil pipe line between Wood River, Illinois, and Lima, Ohio, he said, and it should be completed early next year. Ohio Oil has also joined with four other companies to form The Platte Pipe Line Company which has started constructing a crude oil line from central Wyoming to Wood River.

Further expansion at the company's Robinson, Illinois refinery will boost its capacity from 30,000 to 40,000 bbl per day, and marketing facilities will be strengthened by building additional products pipe line terminals at Toledo, Ohio, and Mt. Vernon, Indiana.

Oil Firms Are Ordered To Sell Navy Fuel Oil

Four U. S. oil companies have been ordered by the Petroleum Administration of Defense to supply the navy with 2,100,000 bbl of Navy special fuel during October, November, and December.

The order included Esso Standard Oil Company, Socony Vacuum Company, Gulf Oil, Sinclair Oil and Refining. These companies are ordered to "meet the shortage in supplies of navy special fuel oil." Fourteen other companies will be ordered to supply on a pro rata basis, grade C fuel oil to the four firms, PAD said.

Navy special fuel is a low-viscosity oil that must meet certain stringent specifications set by the Navy.

Texas Mid-Continent Elects New Officers

Robert F. Windfohr, independent oil producer of Fort Worth, Texas, was elected president of the Texas Mid-Continent Oil and Gas Association in Beaumont recently. He succeeds R. B. Anderson, Vernon, manager of the W. T. Waggoner Estate, who ended four years service as president.

Windfohr is a partner in the oil firm of Nash and Windfohr, and also Nash, Windfohr and Brown.

Harry W. Bass, Dallas, independent oil and gas operator, was elected vice president of the Texas Mid-Continent Oil and Gas Association's newly created North Central Texas district. Bass heads the Harry Bass Drilling Company and is a director of Texas Mid-Continent and Independent Natural Gas Association of America.

(See pages E-6 and E-7 for photos of the meeting.)

Steel Production Hits New High in Third Quarter

The American Iron and Steel Institute has reported that more steel was produced in September, the third quarter, and the first nine months of 1951 than ever before in corresponding periods. In September production totaled 8,644,000 tons, compared with 8,204,997 tons in September of last year. In the third quarter 25,056,839 tons were produced compared with 23,530,093 tons in the same period of 1950, and at the end of the first 9 months, the total equalled 78,328,742 tons, a 9.2 per cent increase over 1950's first nine months.

The oil industry has been allocated 1,708,500 tons of steel for the first quarter of 1952 by the National Production Authority. This is a cut of 98,000 tons from the 1,806,500 tons allowed for the current quarter.

Metals Experts Make Tour

Fifty distinguished scientists and technologists representing leading metals producing companies in 17 foreign countries scattered over three continents recently completed an unprecedented inspection tour of Lebanon Steel Foundry.

Here as members of Study-Tour No. 1, sponsored by the American Society for Metals and the Economic Cooperation Administration, the foreign visitors comprised the initial group of touring foreign technicians scheduled to visit 150 leading metal producing and fabricating plants and research facilities in 13 states and 57 cities in connection with the World Metallurgical Congress. In all, approximately 500 foreign technologists constituting 10 study groups participated in the tours, culminating in their attendance at the World Metallurgical Congress in Detroit.

Guests at a recent meeting of the Los Angeles Nomads included: J. W. Clampitt, Iraq Petroleum Company; Robert B. Loughboro, Arabian American Petroleum; Roy H. Haug, Arabian American; Ralph H. Connor, Santa Fe Drilling. Back row: F. R. Wilmer, Shell Oil of Venezuela; Dr. Albino M. R. De Souza, Conselho Nacional do Petroleo, Brazil; O. J. McBroom and Pedro Connor, Iraq Petroleum. Speaker was J. T. Gould, Corona Oil Specialties and Service Company. He is with J. A. Engstrand, president.

Middle East Oil Discussed At L. A. Nomads Meeting

Jay Gould, engineer for many years for Iraq Petroleum Company in the Middle East, and now president of Corona Oil Specialties and Service Company, spoke on the Middle East oil situation, at the Los Angeles Nomads meeting recently at the Jonathan Club. Gould discussed in particular the Russian threat, pointing out that Russia could keep oil from us but that it would take 10 years for them to get transportation facilities to use it themselves. He indicated the strategic position of Turkey as the key to the Middle East, also the outlook of the average Arab, which led to the Iran crisis.

Walter Main, of Technical Oil Tool Corporation, discussed the oil situation in Peru, both pro and con. He has just returned from a trip to that area.

Dr. Souza, of the Brazilian Oil Commission, made a talk on the need for technical personnel in Brazil—also their activity in the building of a new oil shale plant there. They currently have about 12 rigs operating there and will be purchasing more.

Minerals Yearbook Out

A new volume of the Minerals Yearbook, a basic source of information on domestic and foreign mineral commodities, published annually by the Bureau of Mines, is now available for distribution, Secretary of the Interior Oscar L. Chapman announced.

This issue, containing complete data for the year 1949, as well as comparative data for earlier years, has been improved by new summary tables on domestic mineral production, resulting in uniformity of National State output data. The new national totals pertain exclusively to the production from domestic mines, while in previous issues of the yearbook they included in some instances mineral products made in this country from imported raw materials. Also, the value of United States mine output, as now constituted, is limited to the 48 states and the District of Columbia. Previously Alaska and Hawaii, together with Puerto Rico and other possessions, were included. The Territories and island possessions now appear in separate tables.

Bound copies of the 1949 Minerals Yearbook may be obtained only from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for $4.50 each. All of the chapters of the book are also available at from 5 to 30 cents each.

Shortage of Engineers In United States

The dwindling supply of American engineers was termed "alarming" by a prominent body of engineers, educators, and industrialists during a Convocation in Stephen Foster Memorial (Hall) on the Campus of the University of Pittsburgh recently. Talks at the meeting all strongly stressed the need for public recognition of the lack of engineering manpower. It was pointed out that 95,000 engineers were needed to satisfy industry and the military, but only 38,000 were graduated from colleges this year.

ASCE to Honor 100th Year With Celebration in 1952

Distinguished speakers at the Centennial of Engineering to be held in Chicago, Illinois next summer include Herbert Hoover, Charles E. Kettering of General Motors, and B. F. Fairless, president of U. S. Steel.

The celebration will extend from July 1 to September 30, Lenox R. Lohr, Centennial president has announced. Lohr also reported that 41 national and international engineering bodies are participating in plans for the event.

Occasion for the Centennial will be the one-hundredth anniversary of the American Society of Civil Engineers, oldest U. S. engineering society.

Oil Progress Week Remarks By Leading Oil Men

Oil Progress Week, celebrated last month, throughout the nation, brought many and varied comments on the oil industry. In all, however, there was the thought that "the oil industry will do everything necessary to fulfill its obligations to the country, but will fight to remain fundamentally free."

Walter S. Hallanan, speaking at a dinner in Fort Worth, said: "The oil industry has placed its house in order. It is ready for any emergency. American oil reserves totalling thirty billion barrels cast a darker shadow of fear over the Kremlin than does our stockpile of atomic bombs."

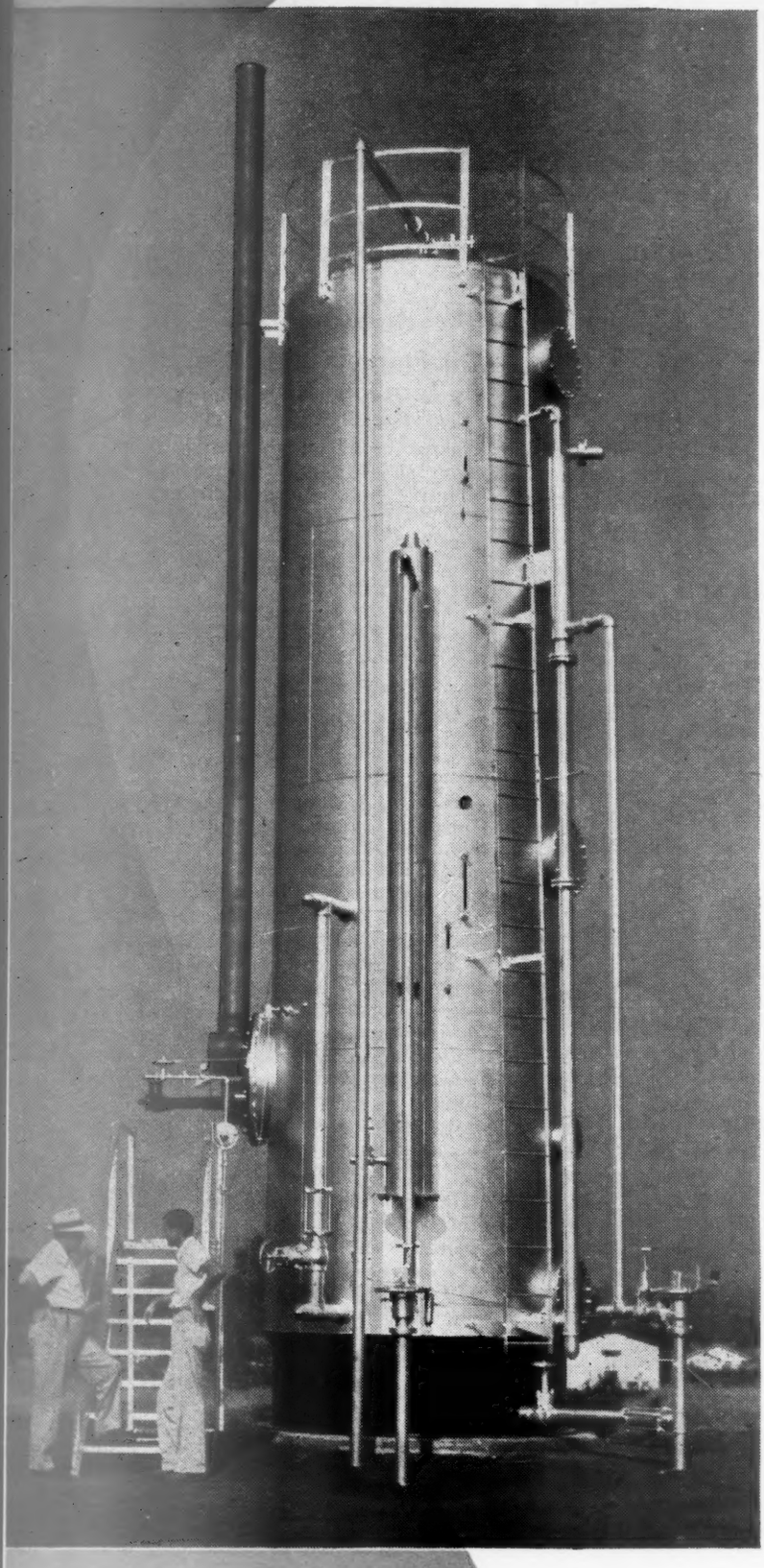
Sidney A. Swensrud, president of Gulf Oil Corporation, speaking in Cincinnati, Ohio, declared, "The biggest single fact that the oil industry can report is that it has successfully kept pace with a 22 per cent increase in demand in the U. S. during the past 2 years."

In California, R. L. Minkler, president of the Western Oil and Gas Association, stated ". . . as long as the oil industry is unhampered in its efforts, there will be no shortage in gasoline and other petroleum products for civilian purposes, save for a military emergency."

Dr. Robert E. Wilson, chairman of Standard Oil of Indiana, asks, "Can you imagine the government engaging intelligently and efficiently in a wildcatting operation? Can you imagine the secretary of the interior explaining to a senate committee why they drilled 80 per cent of places that proved dry? Or, what is more likely, trying to explain why all the Democratic county chairmen had their ranches drilled on and Republicans didn't."

Loss of Iranian oil is not a disaster for the nations of the free world because of the vitality of the American oil industry working under the competitive enterprise system, stated A. L. Nickerson, Socony-Vacuum Oil Company, Inc.

"For EFFICIENCY, ECONOMY



I Like the

Says **BILL MARTIN,** *Production Supt. for Roger Lacy, Inc., Longview, Texas*

First to try the new BS&B Type "J" Treater in the Kilgore field, progressive Roger Lacy, Inc., leading independent producers in the East Texas-Louisiana area, have just installed two more Type "J" to handle emulsion conditions at Kilgore. The results obtained by the initial installation must have justified it!

Says straight-shooting Bill Martin, long-time production superintendent for Roger Lacy (*he's also a consistent medal-winning rifle marksman*)—"My job calls for production of high gravity oil at lowest cost per barrel. The Type "J", requiring less heat, does a better treating job; the Type "J's" simplicity of operation and ease of adjusting the water level means less maintenance cost. And BS&B's service department has certainly lived up to the slogan "Efficiency and Reliability." This all adds up to a lower-per-barrel production cost than we could get with cheap or less efficient equipment."

Foresighted Roger Lacy, Inc. has found it practical to install efficient, economical BS&B Type "J" Treaters to meet increasing salt-water conditions in the Kilgore field. By providing ample treating capacity, additional wells can be connected as they require treating. Lacy's Type "J" Treaters—two 8 ft. and one 10 ft.—are designed to handle the 18 Lacy wells in the immediate area.

SIMPLICITY and SERVICE...

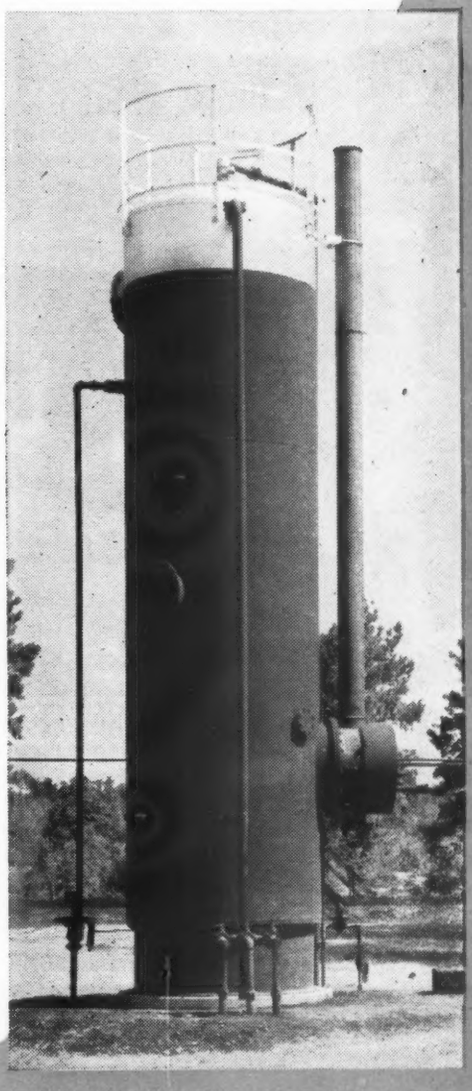
BS&B TYPE "J" TREATER"

Higher Gravity — Greater Capacity — Better Separation *Mean Lower Treating Cost Per Barrel with the New BS&B Type "J" Treater*

Like Roger Lacy, Inc., of Longview, Texas, other producers throughout the oil country are finding it profitable to handle treating problems with the new BS&B Type "J" Treater—doubly profitable because the exclusive Type "J" operating principles produce more and higher gravity oil at a lower cost per barrel.

Here's Why—The Exclusive Type "J" gas cycle minimizes gravity loss through "cold" initial gas-oil separation . . . larger capacity gas separating section . . . longer settling time in quiet, gas-free section . . . less heat in firebox by using heat of treated oil . . . single, more easily adjustable water siphon . . . efficient, removable, easy to clean firebox (without draining oil from treater) . . . highest water removal capacity through pre-heating of emulsion . . . lower fuel, operating and maintenance cost—and greater capacity, higher gravity of oil to tanks.

TYPE "J" TREATERS available in sizes and capacities to meet your treating requirements from 100 to 3,600 bbls. a day—4′ x 28′—6′ x 28′—8′ x 28′—10′ x 28′.



BS&B TYPE "S" TREATER

built for economical pressure operation on less difficult treating conditions. This So. Louisiana installation for a major oil company is *"Doing a 100% job at lower fuel cost"* according to the engineer in charge.

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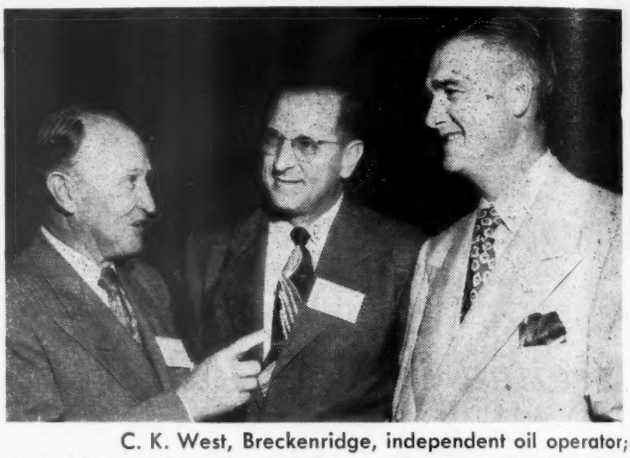
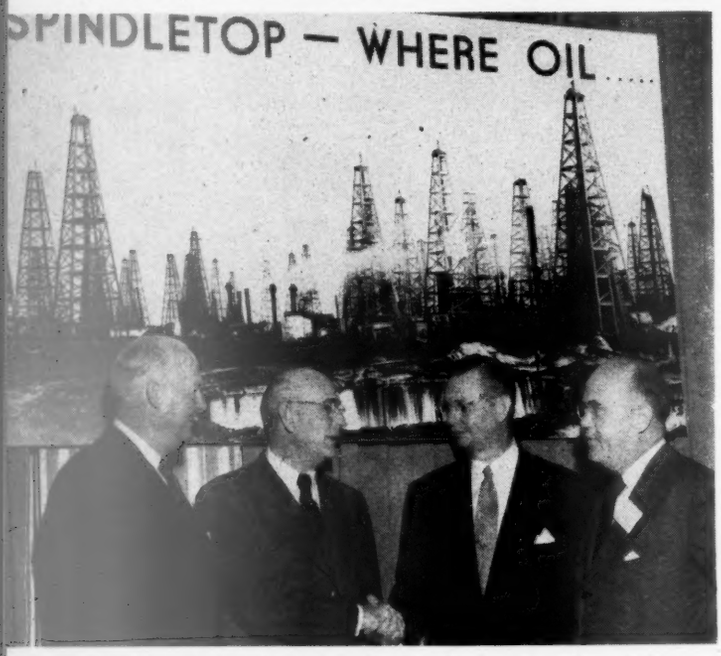
Texans Combine Convention And Spindletop Anniversary

THE thirty-second annual meeting of the Texas Mid-Continent Oil and Gas Association was held in Beaumont October 7-8 with the closing of a year's observance of 50th Anniversary of the Spindletop discovery. Here are pictures of the highlights of the meeting where a new president was elected and two members were presented Service Awards. Secretary of Interior Chapman and Secretary of Army Pace were among the speakers.

Retiring president R. B. Anderson, left, manager of the W. T. Waggoner Estate, Vernon, congratulates R. F. Windfohr, Fort Worth independent operator, as he takes over the presidency of the Texas Mid-Continent Oil and Gas Association.



C. K. West, Breckenridge, independent oil operator; G. R. Whitney, The Chemical Process Company, Breckenridge; Edward J. Brook, president, McElroy Ranch Company, Ft. Worth.



Speakers gather following the first business session of the meeting. Left to right: W. Alton Jones, president of Cities Service and chairman of API; John W. Newton, Magnolia Petroleum, Beaumont, and chairman of the Spindletop 50th Anniversary Committee; R. B. Anderson and Charles E. Simons, vice president and general manager, Texas Mid-Continent.

Anthony Lucas, with Mrs. Lucas, unveils a portrait of his father, Capt. Anthony F. Lucas, of Spindletop fame, at the dedication of the new Anthony F. Lucas Engineering at Lamar State College of Techonolgy.

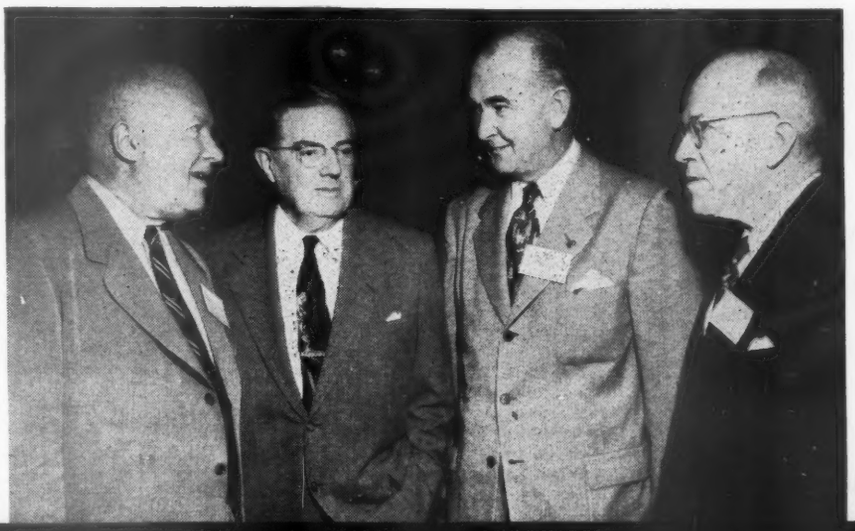
Delegates of the Texas Mid-Continent 32nd Annual meeting in Beaument, October 8-9 at the opening business session.

Arch H. Rowan, left, Fort Worth independent oil and gas operator, receives congratulations from F. J. Adams, vice president, Gulf Oil Corporation, Fort Worth, after Adams had presented him with the Texas Mid-Continent Oil and Gas Association's Distinguished Service Award.

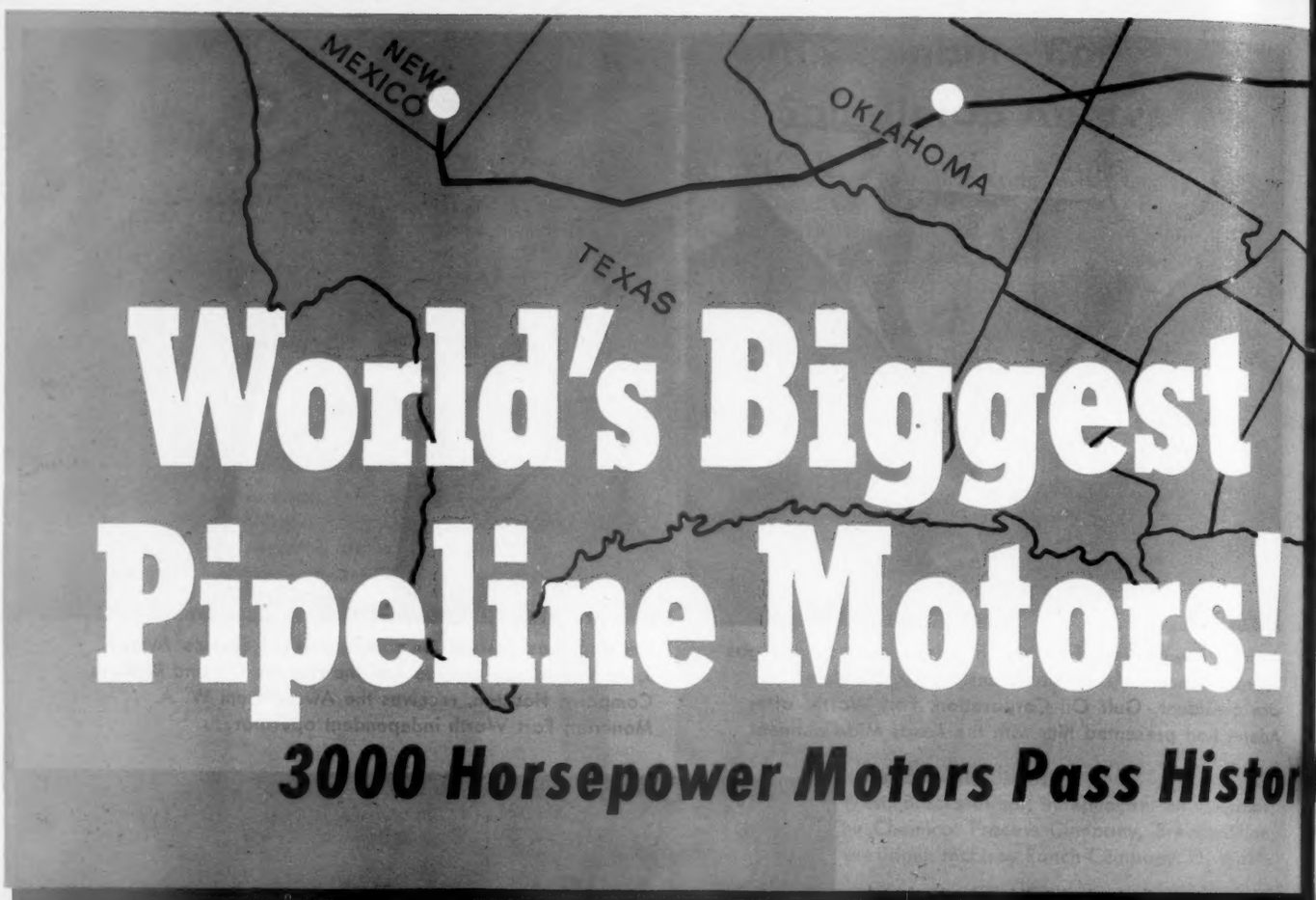
J. A. Neath, vice president of the Humble Oil and Refining Company, Houston, receives the Award from W. A. Moncrief, Fort Worth independent operator.

Photographed when talking in the hotel lobby are: Harry J. Polk, The California Company, New Orleans; Theodore E. Swigart, president of the Shell Pipe Line Company, Houston; A. E. Groff, Shell Pipe Line Company, Houston; and A. E. Jago, Shell Oil Company, Houston.

At left is a smiling group at the Beaumont Hotel: Don C. Wiley, Oil Transports, Inc., Wichita Falls; B. R. Gamblin, Oil Transports, Inc., Abilene; W. H. Wright, manager of the Vernon Chamber of Commerce; C. A. Jackson, The Ohio Oil Company, Findlay, Ohio; and Harold Kennedy, The Ohio Oil Company, Washington, D. C.



Right, Frank Porter, president of API, talks to W. Pack, Sun Oil; Frank Brinegar, Continental Supply; and R. S. McFarland, Seaboard, Dallas.



World's Biggest Pipeline Motors!

3000 Horsepower Motors Pass Histor

Pipeline news! Now being installed are four new booster stations on the Basin pipeline system, owned and operated on an undivided interest basis by the Texas Pipe Line Company, Shell Pipe Line Corporation, Sinclair Pipe Line Company and Cities Service Pipe Line Company. Each station will use two multi-staged centrifugal pumps, each pump driven by a 3000 hp, 1750 rpm, squirrel-cage induction motor.

These are the largest electric motors and centrifugal pumps ever built for pipeline service, *doubling the horsepower of any motors previously used for oil pipeline pumping*. Recently these motors and pumps passed rigorous acceptance tests at Oakland, California.

It was a big job from start to finish. Starting the 3000 hp motors across-the-line without a large voltage drop and resulting disturbance to the power line was the critical factor in motor design. E-M engineers, using a special design for the winding, slots, length of magnetic core, and various other factors, were able to make the starting current low enough to keep the voltage drop within the specified limits . . . still furnishing sufficient torque to accelerate the motor and pump to full load speed with

Making Acceptance Tests

open discharge. By holding motor losses to a minimum and correctly balancing other elements of the design, they were also able to achieve the desired high efficiency and high power factor.

Also extremely important was reliability. The motors have to stay on the job efficiently in around-the-clock pumping station operation. E-M engineers built this dependability into the motors with vacuum pressure impregnated coil insulation of high dielectric strength, precision rotor balance for minimum vibration at high speed, and a tough, rigid frame of welded heavy steel plate designed to withstand any stresses encountered in service.

Left . . . 3000 hp, 1750 rpm squirrel-cage induction motor with enclosing covers for forced ventilation driving a three-stage 14-inch centrifugal oil pipeline pump, on test.

WILL INCREASE PUMPING CAPACITY OF SYSTEM

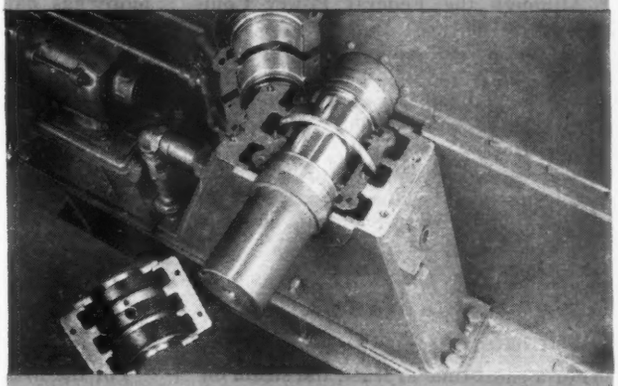
When installation is completed, eight of these 3000 hp motors plus seven 1250 hp units of similar type will help add 100,000 barrels per day, increasing by 40% the pumping capacity of the system.

Looking ahead to future benefits, the entire job from problem to solution is a notable engineering achievement in substantially increasing practical unit size of pipeline equipment. *E-M Synchronizer* No. 34 carries a detailed story on the design of these big motors. Write the E-M factory and ask for it.

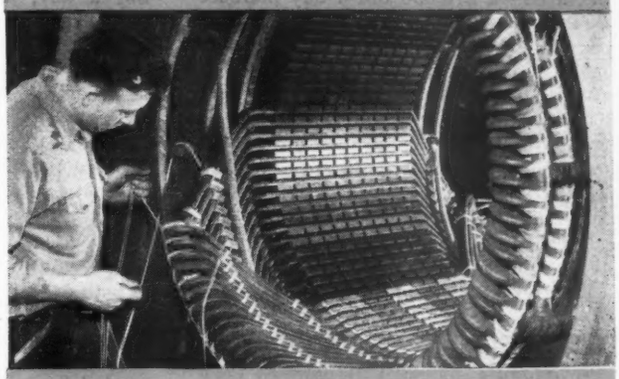
ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

The superfinishing machine below applies an oscillating "harmonic motion" to the bearing journal of E-M's big motor, honing it microscopically smooth. Result is minimum friction and cool running at high motor speeds.

Pedestal type bearings are lubricated systematically by a separate motor-driven pump which forces oil into the bearings. A special oil ring gives sufficient lubrication for starting and acts as an added safety factor. Bearings are made by precise Kolene process centrifugal casting.



Coil ends are "lifetime lashed" to each other and to heavy bracing rings. High strength, neoprene-treated spunglass cord is used for coil lashing. As a result, this coil end structure of high rigidity and great strength is able to resist distortion from full voltage starting.



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Public Being Hoodwinked on Gas, Says K. S. Adams

Self-styled champions of the natural gas consumer are trying to hoodwink the public into believing federal control of producers and gatherers of natural gas would mean more gas at lower prices, when the fact is that it would mean less gas—at higher prices, K. S. Adams, chairman of Phillips Petroleum Company, told more than 600 business and civic leaders of the greater Kansas City area and the Southwest in an address given under the auspices of the Oil Men's Club of Kansas City.

The producer and gatherer receive only a small fraction of what the home consumer pays for gas, Adams declared. In Wisconsin, for instance, the average domestic consumer pays from $1.43 to $2.18 per 1000 cu ft for natural gas, for which the producer receives only 8.1 cents—one-seventeenth to one-twenty-seventh of the amount paid by the consumer.

Although the Federal Power Commission recently ruled by a 4-to-1 majority that producers and gatherers such as Phillips are not subject to regulation under the Natural Gas Act, the decision probably will be appealed to the courts, Adams said. Meanwhile, natural gas producers and gatherers are hesitating to sell gas in interstate markets because of the threat of federal control. This has created an artificial barrier between consumer and producer, impeding the free flow of natural gas from the producing to the consuming states.

If selling gas for use outside the producing state may make them liable to federal control, gas producers are driven to sell their gas at home instead of for export from the state. The demand for gas in the southwestern producing states has skyrocketed in recent years. Industry there, in addition to using gas for fuel, is using it as a raw material to produce all kinds of chemicals such as plastics, synthetic fibers, and fertilizers.

In 10 years the petrochemical industry in the gas producing states of Arkansas, Louisiana, Oklahoma, and Texas, has grown into a billion-dollar enterprise. Today these states have 720 chemical plants that use natural gas. Each of a number of these plants uses more gas daily than do all the home consumers in Kansas City.

The industrial future of Kansas City and many other communities will be adversely affected if the supply of natural gas is uncertain for prospective new industries and for expansion of existing plants, Adams warned. If federal regulations should become a reality, consumers everywhere will be hurt.

Brown Warns Nation Oil Rationing Possible

For a short time at least, the strain on U. S. oil producers and stocks has been temporarily eased. Two things caused the slight relief, Petroleum Administration for Defense head Bruce K. Brown declared—a 270,000 bbl a day increase in crude production by U. S. and British companies in the Middle East outside Iran, and a reduction of 75,000 bbl a day in foreign requirement.

Brown warned, however, that if the Iranian shutdown continues until 1952 requirements will increase and the U. S. will be called upon to increase its supply.

Speaking at Louisiana's celebration of the 50th anniversary of its oil industry, Brown hinted that rationing was a possibility. He said if the oil industry is not given the steel it needs for expansion, protests will be heard from automobile and home owners.

Texas Oil Allowable Cut First Time Since June

For the first time since last June, The Texas Railroad Commission has cut permissible oil production in that state. The total amount of oil that may be produced this month in Texas is 3,005,081 bbl a day, a decrease of 98,184 bbl daily from that in effect on October 13. The state in general will operate on a 23-day producing pattern in this 30-day month. This compared with 25 days in October's 31-day month.

Crude oil production will be reduced in 11 of the 12 districts, with the sharpest cut coming in District 8 (West Texas), where production will go down 47,982 bbl a day.

This cut in production allowables was thought due to the recent buildup of crude oil stocks and refined product inventories which led most purchasers to lower the amount they felt would be needed from Texas.

U. S. Oil Imports Nearly Lowest for Over a Year

Imports of foreign oil and products totaled 644,300 bbl for the week ended October 6, according to the American Petroleum Institute report. This was among the lowest levels hit for more than year. The week ending September 5 marked the lowest since the API reports on imports began, when the total dropped to 601,700 bbl.

The following table includes figures on imports of crude and residual oil as set out by the API:

Four weeks (average) ended	Crude oil	Residual oil	Other products	Total
October 6	489,000	214,700	.....	644,300
Week ended				
September 15	411,200	168,200	22,300	601,700
September 22	634,500	185,200	29,000	848,700
September 29	521,200	250,100	24,600	795,900
October 6	489,000	214,700	19,000	722,700

Oil Output in March More Than February Total

During March, world production of crude petroleum averaged 11,503,000 bbl daily, an increase of 143,000 bbl over the February rate. The principal increases in daily average production were: United States, 122,000 bbl; Venezuela, 42,000; Kuwait, 16,000; and Saudi Arabia and British Borneo each 5000 bbl. The principal decreases in daily production were: Canada,, 18,000 bbl; Indonesia, 10,000; and Mexico, 6000 bbl. In March, record monthly production totals were attained in the United States, Venezuela, and France. During the quarter ending March 31, world daily crude production was 11,373,000 bbl, an increase of 20 per cent over the first quarter of 1950.

Western Europe's daily average imports of crude petroleum decreased 57,000 bbl to 934,000 in March. Imports of crude petroleum into the United Kingdom in March exceeded the January receipts, which had been previously the highest monthly import total. During the first quarter of 1951, Western Europe's crude imports averaged 915,000 bbl daily, 46 per cent more than in the first quarter of 1950.

Statement of the Ownership, Management, Circulation, etc., Required by the Act of Congress of August 24, 1912, and March 3, 1933, of
THE PETROLEUM ENGINEER

Published monthly at Dallas, Texas, for October 1, 1951.

State of Texas, County of Dallas, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared W. T. Bryan, who, having been duly sworn according to law, deposes and says that he is the Business Manager of

THE PETROLEUM ENGINEER

and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to-wit:

1. That the names and address of the publisher, editor, managing editor, and business managers are:

Publisher: The Petroleum Engineer Publishing Company, P. O. Box 1589, Dallas, Texas.

Editor: K. C. Sclater, P. O. Box 1589, Dallas, Texas.

Managing Editor: Ernestine Adams, P. O. Box 1589, Dallas, Texas.

Business Manager: W. T. Bryan, P. O. Box 1589, Dallas, Texas.

Advertising Manager: T. J. Crowley, P. O. Box 1589, Dallas, Texas.

Stockholders holding 1 per cent or more of total amount of stock: W. T. Bryan, T. J. Crowley, W. L. Love and K. C. Sclater, all of Dallas, Texas.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustees or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock, and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has an interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

W. T. Bryan, Business Manager.

Sworn to and subscribed before me this 19th day of October, 1951.

[Seal] Lillian H. Johnston

(My commission expires June 1, 1953.)

PERSONALS

S. A. Wickstrom, petroleum engineer, was elected assistant vice president in the oil and gas department of the Second National Bank in Houston, Texas at a meeting of the board of directors. A graduate of the Colorado School of Mines, Wickstrom has been with the bank for five years as a petroleum engineer. Before his association with the Second National Bank, he was assistant division engineer in the Houston office of the Stanolind Oil Company.

E. H. Blum, widely-known in oil industry circles in the Southwest and Philadelphia, has retired as vice president and director of The Atlantic Refining Company and general manager of the company's crude oil production department.

Blum is a native of Philadelphia and has been a resident of Dallas, Texas, for more than 30 years. He joined Atlantic early in 1905 and in 1936 he was elected a vice president and was appointed general manager of Atlantic's domestic crude production department, serving in that capacity until 1946 when he was put in charge of all of the company's producing activities, both domestic and foreign. He was elected a director of the company in 1937.

Harry C. Carr, chairman of the board of the First National Bank of Philadelphia, was elected to the board of directors of The Atlantic Refining Company. Carr fills the vacancy on the board caused by Blum's retirement. Carr has been prominent in Philadelphia business life for nearly 40 years. A director of the First National Bank of Philadelphia, he was elected president in 1941 and in July, 1951 became chairman of the board.

Roger Gilbert

Roger Gilbert will become the full time chief executive officer of Panhandle Producing and Refining Company January 1. He has been a member of the Atlas Corporation organization since 1931 and a vice president during the past 12 years. He has been a director and chairman of the executive committee of Panhandle Producing and Refining since 1947.

John V. Boyce has announced his retirement as chief executive to take effect at the end of the current year.

Lloyd R. Jackson has been named an assistant director of Battelle Institute, Columbus, Ohio. He will handle research coordination. The new assistant directorship results from the increasing demand by industry and government for Battelle research. Jackson is known particularly for his work on the engineering properties of materials. He has been associated with much of Battelle's research on fatigue, creep, plastic flow, and structural analysis, and is author or co-author of more than 40 technical papers.

A graduate in electrical engineering from the University of Colorado, Jackson received the Master of Science degree in physics from Yale University in 1932. Before joining the Battelle staff in 1935, he was a member of the research staff of the Jones and Laughlin Steel Corporation.

James E. Clark, coastal division manager, Ventura, Shell Oil Company, moves to Casper, Wyoming, as manager of the company's Rocky Mountain division. His new territory includes the Montana section of the important new oil producing area in Williston Basin. Clark replaces **Paul L. Kartzke,** who goes to New York head office on special assignment.

Clark joined Shell in 1933 as a pipe liner at Long Beach, became a division production foreman in 1941, and was elevated to manager at Ventura in 1948. He was graduated from Stanford University just prior to joining Shell.

B. P. Eastin, presently manager of Shell's Los Angeles Basin operations, replaces Clark at Ventura as manager of coastal division. Beginning as a roustabout in 1938, Eastin worked for the company a year, then returned to the University of California at Berkeley for a masters degree.

Clarence E. Booz, Jr., has been appointed head of the safety unit of the employee relations department, Gulf Oil Corporation. Booz joined Gulf in 1928 as a pipefitter helper and was subsequently transferred to the safety department. In January of 1940, he was appointed safety director of the company's three refineries in Texas and served in that capacity until his most recent appointment.

Oscar B. Lewis has been elected vice president of Ethyl Antiknock, Ltd., Canadian subsidiary of Ethyl Corporation, it is announced. He succeeds William M. Turnley who has retired but remains as a director and consultant. An Ethyl employee for 24 years, Lewis has been general manager of the Canadian company for the last year. He is a graduate of Dartmouth and Columbia.

Lewis joined Ethyl Corporation in 1927, and was engaged in promotional work in New York and New England. The introduction of "Ethyl" gasoline in England took him to that country later the same year. He returned to the United States in 1929 and subsequently was engaged in sales and safety work.

John H. Gray

John H. Gray has been named director of public relations for Lion Oil Company. Gray formerly was in an executive position with The Wall Street Journal's Southwest Edition in Dallas, Texas. A native of Newark, New Jersey, Gray was graduated from Cornell University, Ithaca, New York, in 1940. Gray is a member of the national journalism society, Sigma Delta Chi. He served in the Army from 1941 to 1946.

Charles L. Lewis has been appointed supervisor of operations of the treasury department of The Texas Company. First employed by Texaco in 1922 as a clerk, Lewis advanced through various posts in the treasury department and in 1944 was named assistant to the management, in charge of the New York payroll.

R. W. Weiler has been named assistant treasurer and general credit manager. He succeeds **F. J. McEvoy,** who retired from the company after 36 years of service. **W. A. Starr** has been appointed assistant general credit manager.

Robert B. Ogden becomes manager of the foreign shipping department of Socony-Vacuum Oil Company, Inc. He succeeds the late L. R. Owen. Ogden is manager of the operations division of the company's manufacturing department in New York.

Joseph C. Bernd, retired, formerly with Sinclair Refining Company, has been recommended for a certificate of appreciation by the safety committee of the board of directors of the American Petroleum Institute. The award is being presented at the API's 31st annual meeting in Chicago, Illinois, during a group session on the protection of petroleum facilities. Bernd was recommended for 20 years of service as chairman and member of accident-prevention committees, and especially for his notable contributions in the preparation of API accident-prevention manuals.

Roy S. Bonsib, retired, formerly with Standard Oil Company (New Jersey), has been recommended for a certificate for 7 years of conscientious service as chairman and member of accident-prevention committees.

C. Elmer Townsend, retired, formerly with Sun Oil Company, is being rewarded for service as chairman and member of fire-protection committees.

▸ **F. A. Davies** and **B. B. Howard** have been elected to the board of directors of the Arabian American Oil Company. Davies, who is also executive vice president of Aramco, has his headquarters at Dhahran, Saudi Arabia. Howard replaces **John R. Suman,** who has resigned from the Aramco board.

▸ **Dr. Guillermo Zuloaga** has been elected a member of the board of directors of the Creole Petroleum Corporation. **Willard M. Hall,** who retired from active service some months ago, has resigned from the board.

The new board member is a geologist with 11 years service with the company. He began with Creole in 1939 as assistant manager of the geological department. He became manager of the department in 1945 and in 1948 was appointed to the management committee in which post he will continue.

Dr. Zuloaga received a degree in philosophy and letters from the Central University of Caracas in 1924, and the degree of doctor in geology from the Massachusetts Institute of Technology in 1930.

▸ **Richard N. Tuggle** has been promoted to manager of the tax department of Deep Rock Oil Corporation. He was formerly assistant manager of the department and replaces **William F. Styler, Jr.,** who becomes assistant to W. H. Garbade, Deep Rock president. The new tax department manager has an extensive background in tax work and oil accounting, including one year with Deep Rock and 12 years with other independent oil companies. He is a graduate of Oklahoma University.

Styler, the new assistant to the president, has been manager of Deep Rock's tax department since 1949 when he joined the company. He received his B.S. degree in business administration from the University of Arkansas.

▸ **Trevor H. Clark,** formerly with Federal Telecommunications Laboratories (IT&T), was named director of the division of military research and development at Southwest Research Institute. Also named as a special consultant to the Institute's physics department, Clark is a graduate of Friends University and of the University of Michigan graduate school of physics. He is a senior member of Institute of Radio Engineers, a member of American Institute of Physics, Armed Forces Communication Association, etc.

▸ **Arthur R. Enkemeier,** has been named California Texas Oil Company, Ltd.'s assistant treasurer. For some time prior to his employment by Caltex, he was with the Irving Trust Company for a period of 18 years, from 1923 to 1941.

▸ **H. W. Prentis, Jr.,** has been elected to the Board of Directors of the Atlantic Refining Company. He fills the vacancy caused by the death of A. A. Garrabrant.

DEATHS

▸ **John Evon Nelson,** formerly a director and an executive vice president of the Gulf Oil Corporation and long-time Pittsburgh resident, died suddenly at his home recently. In addition to being a director and an executive vice president of Gulf Oil, Nelson was a member of its executive committee; a member and secretary of its finance committee; a member and chairman of its annuity and the service award committees, and a member of various other policy planning committees. Under his direction, too, were the Gulf building, communications, and insurance departments.

Nelson was born in Scotland and came to the United States with his parents when only one year of age. He received his preparatory education at Park Institute, in Pittsburgh; and then attended Westminster College at New Wilmington, Pennsylvania. Upon graduation with an A.B. degree at 20 years of age, he entered the financial field of endeavor that was to be his life's work when he was employed by the Keystone National Bank in Pittsburgh, in 1900. Two years later he became secretary to Andrew W. Mellon, who was one of the founders of Gulf and later became United States Secretary of the Treasury.

On June 1, 1908, Nelson joined Gulf as secretary to Mellon and assistant treasurer.

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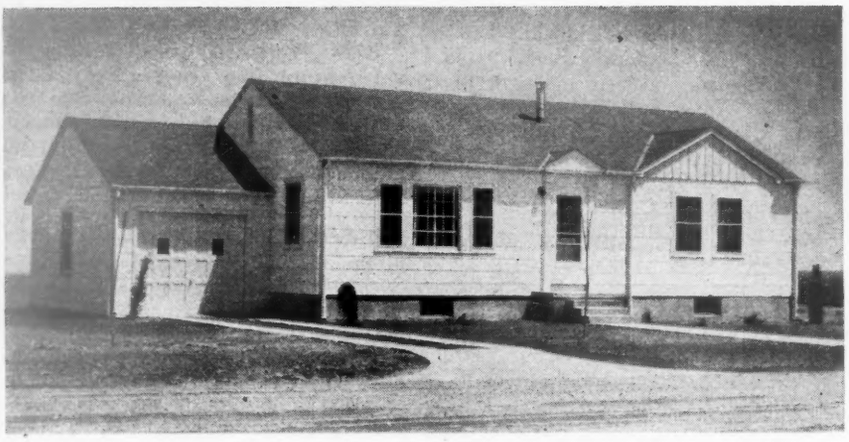

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LAUGH with BARNEY

A fraternity house had sent its curtains to be laundered. It was the second day that the house had stood unveiled and that morning the following note was received from the sorority house across the street:

"Dear Sirs: May we suggest that you procure curtains for your windows. We do not care for a course in anatomy."

The chap who left his shaving to read the note promptly answered: "Dear Girls: The course is optional."

* * *

Little Moron: Have you heard about the little moron who swallowed five pennies and then ran around asking people if they saw any change in him?

* * *

If wives knew what stenographers think of their husbands, they wouldn't worry.

* * *

How did Ole Man River get to be Miss-Sissippi?

* * *

He: Why do you weep and snuffle at a picture show over the imaginary woes of people you never met?"

She: Same reason why you scream and yell when a man you don't know slides into second base."

Boss: These pinheads on the map are my salesmen.

* * *

Serious Young Man: Do you enjoy Kipling?

Giddy Girl: I don't know—how do you kipple?

* * *

Violent exercise after 40 is especially harmful if you do it with a knife and fork.

* * *

Some of the cars around town are so old that the license bureau is making plans to issue them upper and lower plates.

* * *

"I'se wants a ticket for Florence."

Ticket Agent (after ten minutes of weary thumbing over railroad guides): "Where is Florence?"

Mammy: "Settin' over dere on de bench."

* * *

Did you hear about the Scotch moron whose wife was expecting so he took her out to the country because he heard they had rural free delivery?

* * *

Opera is—when a man gets stabbed in the back he doesn't bleed, he sings.

A young man wanted to marry his best girl. He wanted to be frank and tell her a few of the reasons why she might hesitate in marrying him.

He said: "Darling, there are three reasons why you might hesitate to marry me at this time."

"Go on," she said.

He stammered: "In the first place, I have little or no money."

Her instant reply was: "Never mind the other two reasons."

* * *

The dizzy pace is beginning to tell. When three men escaped from a mental institution, searching parties went out and brought back eight.

* * *

Chief Engineer: Your reports should be written in such a manner that even the most ignorant may understand them."

Assistant Chief: Well, sir, what part is it you don't understand.

* * *

Employer (to office boy, who is half an hour late): You should have been in here at nine o'clock.

Office boy: Why, what happened?

* * *

When the young stenographer met her room-mate at the lunch counter, she was brimming over with joy. "I think," she triumphantly announced, "that the boss has decided to keep me!"

"Has he said anything?" her friend wanted to know.

"No," replied the happy girl, "but this morning he bought me a dictionary!"

* * *

"What was the explosion on Caspar's farm?"

"He fed his chickens some 'Lay or Bust' feed, and one of 'em was a rooster."

* * *

The subject of piggy banks was under discussion by two tiny tots.

"I think it's childish to save money that way," said the one tiny tot. "It encourages children to become misers."

"And, that not the worst of it," added her companion. "It turns the parents into bank robbers."

* * *

"Darling," she cooed, "I've just read that a man up north exchanged his wife for a horse, would you?"

"Never," he dutifully replied, "but I'd hate to have someone tempt me with a good car."

* * *

A Russian wolf-hound came over to this country and met an American dog.

"How are things in Russia?" asked the U. S. pooch.

"Oh, fine, fine," said the Soviet dog. "We have fine dog houses and all the red meat we can eat."

"Then what are you doing over here?"

"Hell," said the Red dog, "a fellow likes to bark once in a while!"

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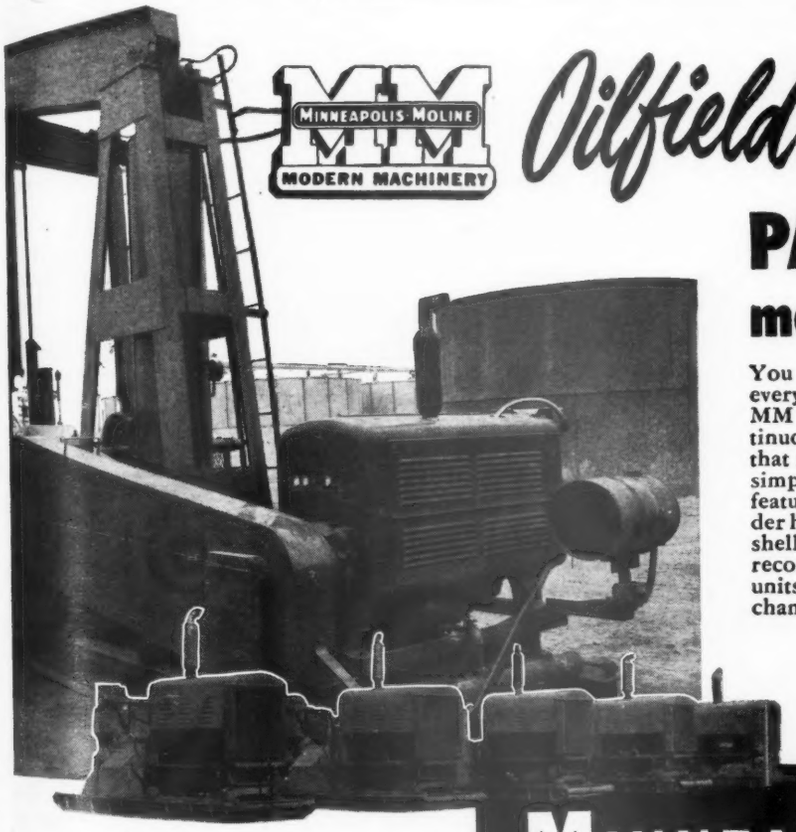

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Sales Headquarters Moved

The local district sales headquarters of The Babcock and Wilcox Tube Company, formerly established at the plant, has moved to new facilities in Beaver Falls, Pennsylvania. The office, which is situated at 712 Eleventh Street, occupies a complete building leased and remodeled by the Tube Company and is convenient to railroads, other public transportation and the local hotel. It has its own telephone connections, including direct wires to Pittsburgh and the plant and TWX service throughout the sales territory covered. The office handles the sale of B&W seamless and welded stainless, alloy, and carbon steel tubing in western Pennsylvania, western New York, Ohio, southern Indiana, and the states of Kentucky, West Virginia, Tennessee, North Carolina, South Carolina, Georgia, Alabama, and Florida, and parts of Canada.

Moorlane Establishes New Denver, Colorado, Offices

Moorlane Company has opened a new branch office and warehouse in Denver, Colorado, at 275 Kalamath Street. D. M. Huffman is branch manager. Moorlane is distributor for Babcock and Wilcox Tube Company, Chiksan Company, Johns-Manville Sales Corporation, Manning, Maxwell & Moore, Inc., National Tube Company, Rockwell Manufacturing Company, Young Radiator Corporation, and many other leading manufacturers.

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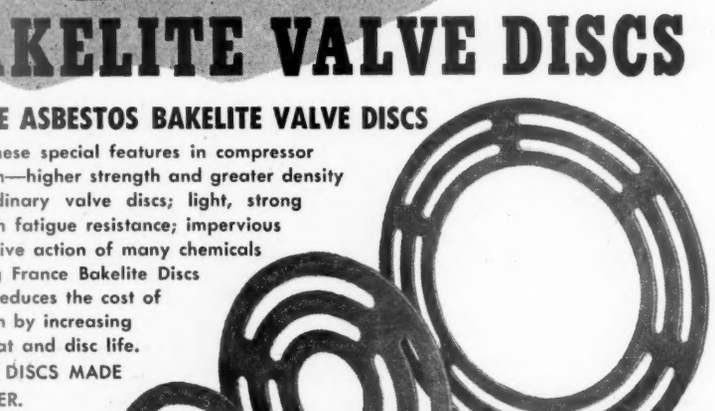
assure these special features in compressor operation—higher strength and greater density than ordinary valve discs; light, strong with high fatigue resistance; impervious to corrosive action of many chemicals ... Using France Bakelite Discs greatly reduces the cost of operation by increasing valve seat and disc life.

SPECIAL DISCS MADE TO ORDER.



A COMPLETE LINE
OF PACKINGS AND PISTON RINGS FOR INDUSTRY

FRANCE PACKING CO.
PHILA. 35, PA.

Valve Designs Is Subject Of House Organ Article

An article in the Edward Valves, Inc. house organ, illustrates and covers in detail the three experimental stress analysis techniques Edward employs during the stages of development of new valve designs to achieve (1) maximum strength, less weight, and greater compactness. The article, entitled "Experimental Stress Analysis Help Shape Up Better Valve Designs," is written by W. L. Hemingway, Edward research metallurgist, and goes on to say that correct interpretation and utilization of experimental stress analysis results have also paid off in lengthening valve life, cutting valve maintenance, etc. The company magazine *Valve Values* may be obtained upon request.

Buffalo Steel Acquired

H. K. Porter Company, Inc., Pittsburgh, Pennsylvania, has acquired the Buffalo Steel Company, Tonawanda, New York, producers of light steel products. With the acquisition of this company and Connors Steel Company, Birmingham, Alabama, last October, Porter now has a total steel production capacity exceeding 200,000 tons. Buffalo Steel Company with a total capacity of more than 70,000 tons a year, is a leading manufacturer of light steel products, producing concrete reinforcing bars, agricultural shapes, fence posts, shelving angles, merchant bars, and other similar steel products.

Kone Named Agents

The appointment of James S. Kone and Company, 1011 Fisk Building, Amarillo, Texas, as sales representative for West Texas, the Panhandles of Oklahoma and Texas, and southwestern Kansas is announced by T. D. Williamson, Inc., Tulsa, manufacturers of pipe line tools and equipment. Kone was associated with Manning, Maxwell and Moore for seven years. He represents the Joseph A. Coy Company, Santa Fe Tank and Tower Company, Warren Lewis, Coppuss Engineering, Daniel Orifice Fitting, and F. H. Maloney.

J. S. Kone

Venezuelan Agents Named

Black, Sivalls and Bryson, Inc., announces the signing of a representative agreement with Oil Field Sales and Service, C.A. of Anaco, Venezuela, to represent its entire oil field equipment line in the South American countries of Venezuela, Colombia, and Trinidad. Oil Field Sales and Service is headed by Allen Pike, president, and jointly owned by Paul Koester. Pike, a graduate of Texas A. and M. College, was formerly with Gulf Oil Corporation as a reservoir and petroleum engineer. Koester, too, is a former Gulf employee.

Rockwell Changes Name Of Tools Subsidiary

The name of the Ohlen-Bishop Manufacturing Company, Columbus, Ohio, a subsidiary of Rockwell Manufacturing Company, Pittsburgh, has been changed to Rockwell Tools, Inc. Ohlen-Bishop, purchased by Rockwell in May of this year, has been organized since 1852. The new name will both closely identify the firm as a member of the Rockwell group and describe the character of its business.

Swartwout Sales Room Open

The Swartwout Company, Cleveland, Ohio, manufacturer of power plant process control, and ventilating equipment, announces the opening of a new sales office in Room 674, M&M Building, Houston, to service the Texas area. J. B. Downey, Swartwout sales engineer, will manage the power plant and process control divisions, and William A. Sharp of Houston will be in charge of roof ventilator sales engineering and service. Downey is a graduate of Case Institute of Technology, and Sharp is a University of Illinois graduate.

Chiksan Company Names Belgium Representatives

Hydrobel, S.A., Liege, Belgium, has been appointed export sales representative by Chiksan Company for Belgium, Grand Duchy of Luxembourg, and the Belgian Congo. This company, which represents a number of American manufacturers, will specialize on the sale and application of Chiksan industrial and hydraulic swivel joints and WECO unions.

Baash-Ross Plant Is Set Up in Odessa, Texas

Baash-Ross Tool Company has opened a new manufacturing plant in Odessa, Texas, making the 17th plant throughout the country. The plant structure has four bays and three craneways, one of which is 460 ft long, with a 60-ft span. A complete range of heavy-duty machine tools is installed in the plant.

The new plant will also serve as headquarters for the Baash-Ross sales and fishing tool operations in the West Texas and New Mexico areas. L. L. (Red) Garren is in charge of the new Odessa plant, while supervision of the field and plant operations under him are handled by Phil Gibbons, district sales manager; Carl Prichard, district service manager; Gordon Ford, plant superintendent and Jess Moody, office manager.

Tinker Papers Chosen For Technical Conference

Three papers dealing with "Shell Side Characteristics of Shell and Tube Heat Exchangers", written by Townsend Tinker, Buffalo, were preprinted for presentation and discussion at a conference of leading North American, English, and European technical societies in London, England, recently. Tinker's papers were selected on invitation of the Joint Committee on North American Participation in the international discussion of outstanding developments in the various fields of heat transmission during the past decade. For the past 16 years, Tinker has been chief engineer of Ross Heater and Manufacturing Company, Inc., Buffalo, New York, a division of American Radiator and Standard Sanitary Corporation.

Townsend Tinker

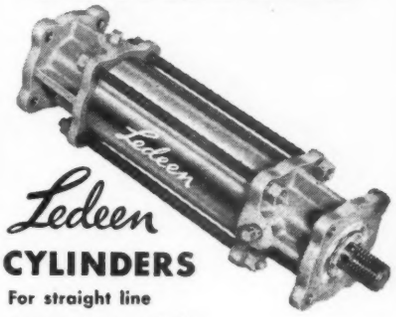
A. O. Smith Managers Take Special Courses

Training facilities at the A. O. Smith product service division were open recently when a special school was conducted for the company's water heater sales executives. Attending the concentrated sessions were district water heater sales manager, W. W. Stake of New York, L. H. Hoelter of Chicago, and G. H. Kemper of Houston; assistant marketing director, H. L. Bilsborough of Los Angeles, and marketing director S. E. Wolkenheim of Kankakee.

Classes, running from 9 a.m. to 7 p.m. for two days, covered application, sizing installation, and servicing of A .O. Smith Permaglas and Duraclad water heaters. The time was divided about half-and-half between lecture sessions and laboratory work. The sales managers took the course to better acquaint them with the comprehensive training available to A. O. Smith dealers.

Baash-Ross Tool Company's newest manufacturing plant in Odessa, Texas. L. L. Garren heads the plant. Phil Gibbons is district sales manager.

SIMPLIFY EQUIPMENT CONTROL WITH Ledeen CYLINDERS



Ledeen CYLINDERS

For straight line power movement. Air, oil or water operation. Medium Duty, Heavy Duty, and Super Duty models.

Write for Bulletin 500.

Ledeen VALVES

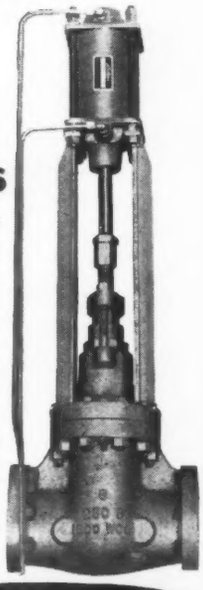
For actuating air or hydraulic cylinders. 14 different models for 5 different cycles, in 6 sizes. Hand, foot and power operated.

Write for Bulletin 510.

Ledeen VALVE ACTUATORS

For actuating any make, size and type of valve, against any line pressure, on any fluid medium, and with any pressure available. For on-and-off or positioning service. Positive in action, economical in cost.

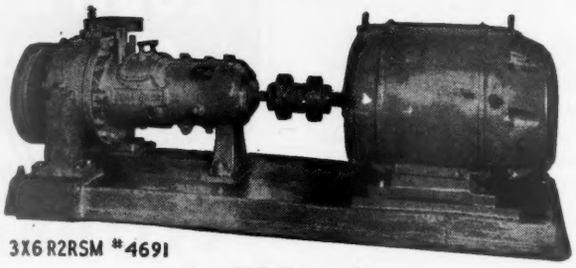
Write for Bulletin 512.



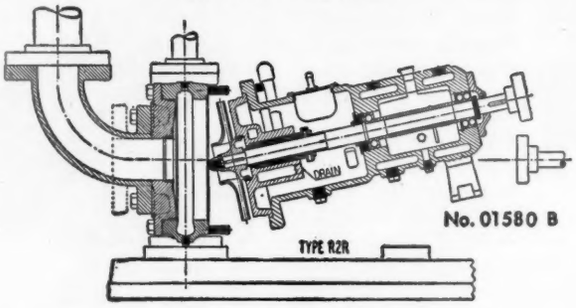
Ledeen Mfg. Co.
1608 San Pedro
Los Angeles 15, Cal.

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

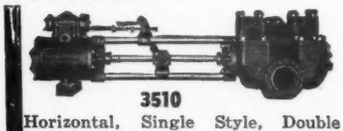
DISASSEMBLY: The Type R2R processs pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

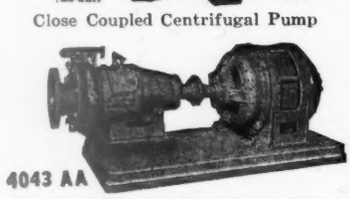
BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

Close Coupled Centrifugal Pump

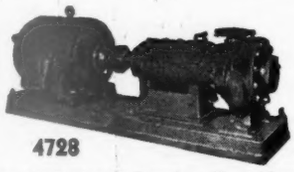


Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

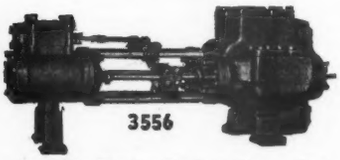


Pedestal Mounted Centrifugal Pump

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump



Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

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DEAN BROTHERS PUMPS INC.

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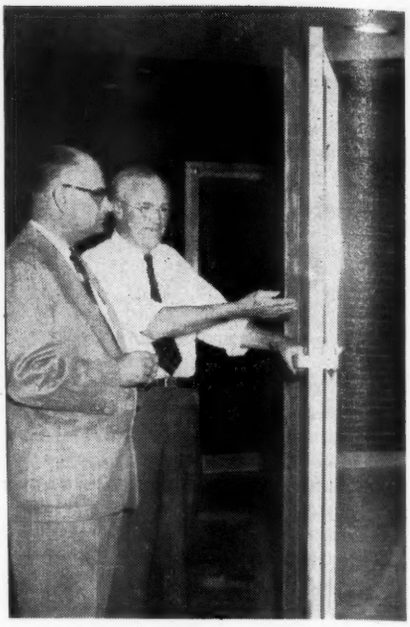
Representatives in Principal Cities



A. F. Davis, vice president of Lincoln Electric shows new building to Mayor Kenneth J. Sims of Euclid, Ohio.

Lincoln Moves Facilities

The Lincoln Electric Company, Cleveland, Ohio has moved all executive and plant offices with their equipment to its new plant at 22801 St. Clair Avenue, Cleveland. The last move, the office move, was one step in the transferring of Lincoln's operations without losing any more than 10 per cent of production for the month during which the complete move was made.

G-E Forms Six New Operating Divisions

The formation of six new operating divisions has been announced by the General Electric Company. The new divisions include the turbine division and the motor and generator division, both with headquarters at Schenectady, New York; transformer and allied products division, with headquarters at Pittsfield, Massachusetts; measurements and industrial products division, with headquarters at Lynn, Massachusetts; switchgear and control division, with headquarters at Philadelphia; and the component products division, with headquarters at Fort Wayne, Indiana.

Together with the recently-announced Defense Products Division, the six new divisions include the majority of the departments which constituted the former Large Apparatus Division and Small Apparatus Division.

Glenn B. Warren has been named general manager of the turbine division. The division includes the large steam turbine and generator department, gas turbine department, medium turbine, and various other departments.

James M. Crawford of Pittsfield, New York, has been named general manager of the motor and generator division. The division includes the large motor and generator department, small and

medium motor department, and Schenectady works service department.

Francis E. E. Fairman, Jr., Schenectady, has been named general manager of the transformer and allied products division. This division includes the transformer and allied products department, and the Locke department.

George E. Burens, Baltimore, is general manager of the switchgear and control division.

Harold E. Strang, Lynn, Massachusetts, has been named manager of measurements and industrial products division, which includes meter, and instrument department.

William C. Wichman of Fort Wayne, Indiana, has been named general manager of the component products division, including the fractional horsepower motor department, specialty transformer and ballast department.

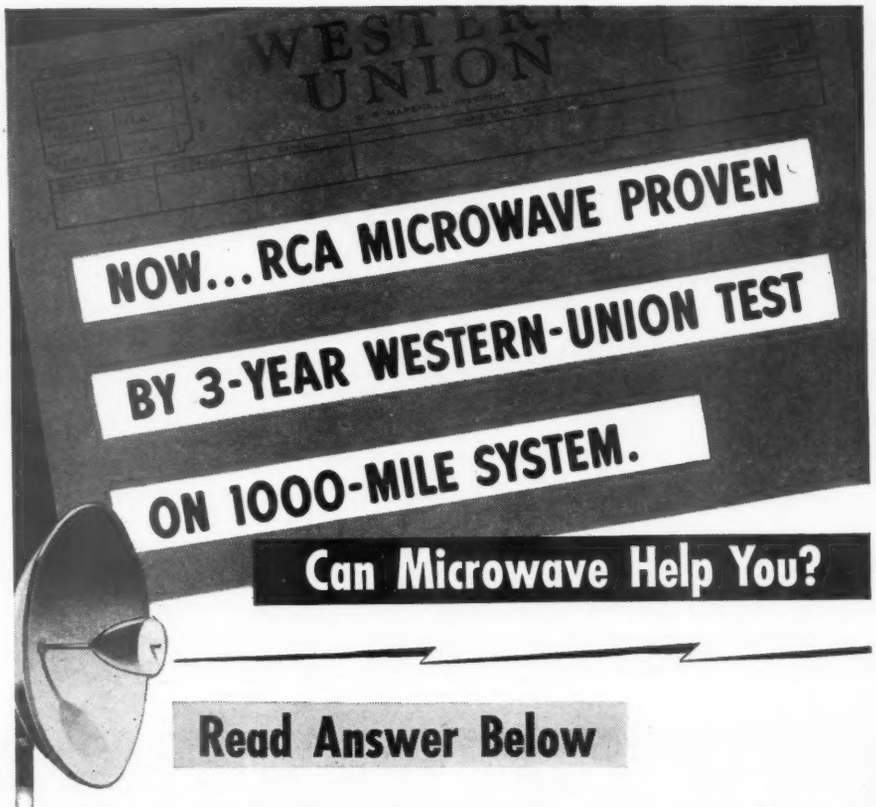
Gillies, Peltz Named To Philco Offices

In a further expansion of Philco Corporation's divisionalization program and to handle the greatly increased volume of industrial and government electronic production, Joseph H. Gillies has been appointed vice president and general manager of the government and industrial division. Robert F. Herr, vice president of the corporation, will continue to head all sales activities of the division, as a general staff executive. At the same time, William J. Peltz, who has been manager of government and industrial operations, was appointed vice president operations of the television and radio division. Gillies joined the company in 1929, was named works manager in 1939 and vice president in charge of radio production three years later.

Peltz, who has been with Philco for 26 years, was named radio production manager in 1942 and was in charge of the company's advanced airborne radar manufacturing in Philadelphia plants during World War II.

Aluminum Plant Set for Construction Work

Construction work on the new Aluminum Company of America (ALCOA) aluminum smelting plant at Rockdale (Milam County), Texas, is scheduled to begin. John D. Harper, who has been assistant district power manager for ALCOA'S Tennessee operations, has been named works manager for the company's Rockdale plant. Len B. Neubert has been appointed construction superintendent for erection of the new aluminum smelting plant, having been transferred from the company's works at Vancouver, Washington. It is expected that the metal-producing facilities at Rockdale will be in partial operation late in 1952. When full operation is reached in 1953, a total of approximately 1000 persons will be employed by the company at the plant. The aluminum production capacity of the plant will be in the neighborhood of 170,000,000 lb annually.



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Since 1948 RCA microwave has been flashing Western Union telegrams from Pittsburgh all the way to Washington, Philadelphia and New York. After more than three years of continuous service, the record for reliability is almost perfect . . . *far better than corresponding experience with land lines.* Western Union has purchased sites for towers so that it can extend microwave to many other areas . . . proof enough of its outstanding performance.

Microwave is "Weather-Proof"

Signals in RCA microwave system travel on radio beam from one parabolic antenna to another. Eliminates outages due to sleet storms because *ice can't form on a radio beam.* Chain of relay towers spaced 25 to 50 miles apart relay signals over mountains and valleys, operate normally unattended. Eliminates pole lines, easements, line maintenance. *Costs less per mile than any other type of system of comparable capacity.*

Can Your Business use Microwave?

If you need *reliable* communications that can span long distances through all kinds of terrain and weather, RCA microwave is the modern money-saving answer. Let RCA engineers survey your situation. Microwave is quick and easy to install. Installation and service is available from the RCA Service Company.

Microwave offers plenty of Capacity

System offers channels for voice, supervisory controls, teleprinter, facsimile, 2-way radio and other circuits. Plenty for all your needs.

Leading Companies use Microwave

Proof of RCA microwave acceptance by industry: users include Pennsylvania Turnpike Commission, Central Arizona Power and Light Co., Arkansas Game and Fish Commission, United Gas Pipeline Company of Louisiana, many others.

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Find out how RCA Microwave can help solve *your* communications problems. Just clip and mail coupon . . . *today.*

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Please send me, without obligation, full story on how new RCA Microwave can give efficient, all-weather communications without pole lines, easements, or line maintenance.

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● Complete line includes inexpensive float and counterweight liquid level indicators for tanks under pressures from 0 to 28 oz. per sq. inch. Also automatic gauges that provide extremely accurate readings without relieving tank pressure. Types for cone, umbrella, floating roof and expansion roof tanks and spheroids. *Write for fully descriptive catalog today.*

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Producing Horizons are ONE MILE DOWN...

But This
WISCONSIN-POWERED UNIT
Economically
Pumps Oklahoma Oil

Because of mile deep wells at this Oklahoma field and lower crude oil prices due to the depreciated dollar, it more than pays this company to use an economical Wisconsin Heavy-Duty Air-Cooled Engine powered pumping unit, supplied by Harley Sales Company.

Actually, there are many reasons why producers everywhere endorse Wisconsin Engines. Maintenance is minimized because of positive lubrication and cooling by air alone. And heavy-duty construction, including tapered roller bearings at both ends of the shaft, and an easily-serviced OUTSIDE magneto with impulse coupling gives you the most horsepower hours of service always.

4-cycle single-cylinder, 2-cylinder and V-type 4-cylinder models, 3 to 30 hp.

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

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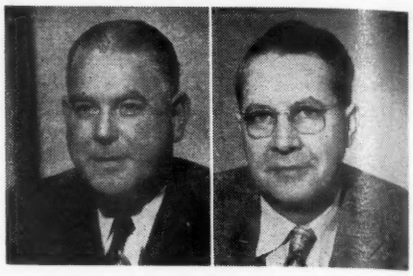
M & M BUILDING, HOUSTON, TEXAS
505 SOUTH MAIN ST., WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.

Guiberson Holds Sales Meet

The Guiberson Corporation held its fall sales meeting in Dallas, Texas, September 27-28 with more than 35 sales representatives and executives of the corporation attending. One of the principal events at the meeting was a clinic on gas lift installations with the Guiberson Type "A" flow valve. Two new packers, Type "WF" water flood and Type "H" hydraulic hold down anchor, were introduced and discussed. Harry S. Zane, Jr., sales manager for the corporation, conducted the meeting. Alex P. Smith, executive vice president and general manager for Guiberson told the group: "Our production of equipment is keeping pace with the high demand of the industry and sales continue to climb."



H. S. Zane A. P. Smith

Detroit Diesel Plans Expansion Program

A $1,000,000 building expansion program to increase production facilities of the Detroit Diesel Engine Division of General Motors is announced by W. T. Crowe, general manager. The announcement highlights a production figure of over 50,000,000 hp in 2-cycle diesel engines attained by the division since 1938. According to Crowe, this is the eighth major expansion the division has made and adds almost 80,000 sq ft to the 1,000,000 sq ft now under cover.

Worthington Promotes Seven Plant Executives

Worthington Pump and Machinery Corporation has named seven plant executives to new posts according to E. J. Schwanhausser, executive vice president.

Manufacturing executives in new posts include: George P. Passmore, assistant to the vice president in charge of manufacturing at Harrison, New Jersey. Passmore has been serving as works manager of Worthington's Wellsville, New York, plant since 1941. A. M. Tullo, works manager of the company's Wellsville, New York, plant. Since 1945 Tullo has been assistant works manager at the Harrison plant. John Burlick, assistant to the works manager at the Harrison plant, in charge of industrial engineering activities. Since 1945 Burlick has been manager of the methods and standard department. Max A. Heyman, assistant to the works manager at the Harrison plant in charge of production control activities. He has been man-

ager of the production department at Harrison since 1945.

...Engineering executives in new posts include: W. D. Sizer, manager of regional engineering and service department, with headquarters at Harrison. Since 1940 Sizer has been executive engineer for the Harrison plant. George F. Habach, executive engineer at the Harrison plant. Since 1945 Habach has been chief engineer of the centrifugal engineering division. Everett Schmachtenberg, chief engineer of the centrifugal engineering division at the Harrison plant. Schmachtenberg has been assistant chief engineer of this division.

Steel Castings Production Approaches All-Time High

Production of steel castings to meet expanding requirements of the defense mobilization program rapidly is nearing record proportions, it was reported by F. Kermit Donaldson, executive vice president, during the annual meeting of Steel Founders' Society of America. More than 250 management executives of steel foundries in all parts of the nation are attending the two-day sessions at The Homestead, Hot Springs, Virginia.

Despite manpower shortages and difficulties in securing adequate supplies of necessary scrap and other raw materials, Donaldson said, the steel castings industry now is producing at a rate rapidly approaching the all time high of 1944, during World War II, when the industry shipped 2,445,421 tons. Currently, he disclosed, the country's 250 steel foundries are operating at a level more than 150 per cent above 1950 and are producing at a rate in excess of 2,200,000 tons yearly, according to official Bureau of the Census figures. This compares to shipments totaling 1,461,667 tons in 1950.

G-E Begins Shipment Of Two-Way Radios

The General Electric Company has announced it has begun shipment of two-way emergency radio equipment from its newly established Kent Street plant in Utica, New York. The plant will be devoted exclusively to the production of this equipment, which is being used for quick communications by public and private agencies throughout the U. S.

G. W. Nutter, plant manager at Utica, said all two-way radio production is being transferred to Utica gradually from the company's Electronics Park plant at Syracuse, New York, so as not to interrupt production schedules.

In addition to its normal use, two-way radio will play a major role in civil defense planning across the nation, he predicted. It can operate in areas under heavy enemy attack, when normal telephone and radio facilities may be destroyed or disrupted, he said.

General Electric's sales in this field during 1951 will be 60 per cent above those of 1950, according to Nutter.

for lasting, dependable trouble-free service

● Complete facilities including heavy duty hydraulically tested tank nozzles; efficient double elbow type swing joints that minimize agitation and pressure drop; sturdy steel swing pipe clamps; cables; internal sheaves or cable sheave bracket assemblies complete with bronze gland stuffing box; and internal or external tank winches. Fully descriptive catalog gives full details. *Write for a copy today.*

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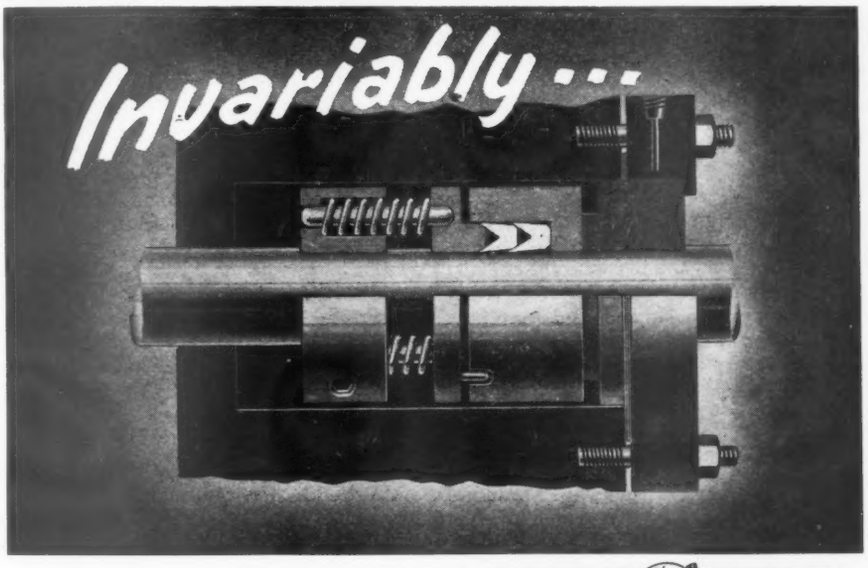

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The PERFECT SEAL
ROTATES WITH TRADE MARK THE SHAFT

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WHERE
....ECONOMICAL OPERATION IS DESIRED
....OPERATING CONDITIONS ARE HAZARDOUS
....LOSS OF COSTLY FLUIDS MUST BE PREVENTED
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GET THE "DURA SEAL" STORY—WRITE FOR BULLETIN 174PE

DURAMETALLIC The PERFECT SEAL CORPORATION
KALAMAZOO MICHIGAN

TRADE PERSONALS

▸ **Charles Ebem Wilson,** sales vice president of the Worthington Pump and Machinery Corporation, Harrison, New Jersey, has been appointed a West Coast consultant on sales problems. In 1946 Wilson, in addition to his other duties, was made president of the Worthington-Gamon Meter Corporation, then a Worthington subsidiary. Wilson has retired from his present position and activities in corporation affairs but will continue in a consulting capacity on sales problems at Worthington's offices in Los Angeles, San Francisco, Seattle and Salt Lake City.

A. S. King

▸ **Alfred S. King** has joined Wilson Meyer Company, West Coast distributors of Eastman industrial chemicals, manufactured by the Tennessee Eastman Company, division of Eastman Kodak. King will supervise technical sales and service work on gasoline additives and other Eastman industrial chemicals. Formerly West Coast representative of the Houdry Process Corporation, he has had extensive experience in petroleum and petrochemical processing.

▸ **Dr. William A. James** was named director of research and **Jerry Shaw** as sales representative for Dearborn Chemical Company. Dr. James will assume charge of all research activities at the Dearborn Laboratories situated at 2454 Dundas St., West, Toronto. Dr. James was formerly senior research chemist for the Standard Chemical Company, Ltd., of Toronto. He received his Ph.D. from the department of chemistry of the University of Toronto in 1939.

A. J. Kerr

▸ **A. J. Kerr,** vice president of meter and valve sales for Rockwell Manufacturing Company has been appointed chief of the valves and fittings branch, general components division of the National Production Authority. He will work under the direction of Eugene S. McCarthy, director of the general components division, and will have his headquarters in Washington, D. C. **Charles W. Burrage,** whom he succeeds, is returning to his job at The Lunkenheimer Company, Cincinnati, Ohio. Kerr is a mechanical engineering graduate of Carnegie Institute of Technology.

E. B. Cutter

▸ **Earl B. Cutter** has joined American Meter Company as assistant to the vice president in charge of sales. A graduate of Iowa State University, Cutter joined the American Meter Company in 1939. His association with the company was interrupted in 1941 by a call to active service with the U. S. Army Corp of Engineers as a reserve Second Lieutenant. Upon discharge in 1946 Cutter resumed his association with American Meter.

▸ **Dan D. Rogers** has been named traffic manager of Mid-Continent Supply Company. A veteran of 26 years in the traffic field, Rogers comes to Mid-Continent from the Missouri and Pacific Railroad Company where he had held the position of chief traffic clerk. Prior to his association with the Missouri and Pacific he had been with the Texas and Pacific Railroad Company and Johnson Motor Lines.

W. E. Lunger

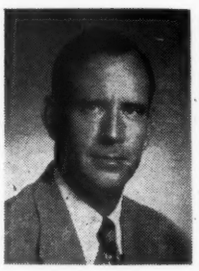
▸ **Wilbur E. Lunger** has been elected a vice president of the American Car and Foundry Company, reporting to R. W. Ward, vice president in charge of production. Lunger was formerly assistant vice president in the production department. Educated in New York, Lunger studied engineering and for two years was trained in shop work at ACF's Berwick, Pennsylvania, plant. In November 1949, he was transferred to New York as assistant vice president.

▸ **John W. Belanger** and **Nicholas M. DuChemin,** have been elected vice presidents of the General Electric Company. Belanger was appointed general manager of the company's newly-created defense products division, and DuChemin was recently placed in charge of the company's manufacturing services division. The new defense products division includes the aircraft gas turbine department with headquarters at Lockland, Ohio and the Aeronautic and Ordnance Systems Department, with headquarters at Schenectady. Before receiving his recent appointment, DuChemin had been general manager of the small apparatus division. His headquarters are the company's executive offices in New York and he also maintains offices at Schenectady.

James F. Lincoln

▸ This year marks the 15th anniversary of the James F. Lincoln Arc Welding Foundation, which was established at the close of 1936 by the board of directors of the Lincoln Electric Company in recognition of Lincoln's outstanding foresight and accomplishments in the field of arc welding. Over a period of 12 years, the Foundation has sponsored three $200,000 award programs to stimulate scientific progress of arc welding in the engineering world through the writing of papers. Following each program, books are published presenting the outstanding award papers.

Upon graduation from Ohio State University, James F. Lincoln joined the Lincoln Electric Company founded by his older brother, John C. Lincoln. Since 1929 the company, of which J. F. Lincoln is now president has tripled its employees and is owned almost entirely by men active in its management and by its wage earners. Lincoln brought about the development of the separately excited direct current arc welding generator with bucking series field and stabilizer in the arc circuit. This resulted in an arc characteristic that made it easy for an ordinary welding operator to weld.



J. L. Tullis

▸ **J. L. Tullis,** general manager of sales for the J. B. Beaird Company, steel fabricating and machining plant at Shreveport, Louisiana, has been appointed to national industrial advisory committees for two federal agencies. He is one of 15 men chosen by the National Production Authority to serve as an advisory committee on matters affecting industries that fabricate steel plate. He has also been appointed by the Office of Price Stabilization to a similar advisory committee representing manufacturers of fabricated standard line pressure and non-pressure tank equipment.

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G. W. Probst

George W. Probst has been named Western regional sales manager of Clark Bros. Company, Inc. He has been associated with the sales department of Clark for the past 30 years. For the past 10 years he has been the district sales manager of the Tulsa district.

In his new position, he will coordinate the sales efforts of the California, Oklahoma, Texas, and Chicago territories. His headquarters will remain in the Clark Bros., Inc., sales office at 125 West First Street, Tulsa, Oklahoma.

James H. McBrien and **Floyd E. Zongker** have been named service engineers for T. D. Williamson, Inc., Tulsa. Both men are experienced in corrosion surveys and the installation of corrosion control equipment as well as inspection of pipe line construction.

Robert C. Becherer has been elected executive vice president of Link-Belt Company, with headquarters at the company's executive offices in Chicago. He was elected vice president last March. He joined Link-Belt in 1923 upon graduation from Purdue University. **Richard E. Whinrey,** assistant general manager at the Ewart plant, Indianapolis, has been appointed general manager of this plant to succeed Becherer in this capacity. Whinrey joined Link-Belt at the Dodge plant in Indianapolis in 1925 upon graduation from Purdue.

DEATHS

G. Frederic Bauer of Elkins Park, Pennsylvania, chief technologist of the National Airoil Burner Company of Philadelphia, Pennsylvania, died August 9, 1951 in Richmond, California while on a business trip. His age was 50. Bauer was with National Airoil Burner Company for 19 years. Of this time 3 years were given over to oil combustion work for stationary and marine boiler plants. For 4 years he specialized in oil and gas problems for the glass, ceramic, and steel industries. The last 12 years were spent on chemical and refinery combustion development.

William C. Johnson, a native of Birmingham, Alabama, and executive vice president of Allis-Chalmers Manufacturing Company, unexpectedly died July 26, following a heart attack suffered in the night. He was also a member of the firm's board of directors and a member of the executive committee of the board. In addition, Johnson served as chairman of the board of Canadian Allis-Chalmers, (1951) Ltd. He joined Allis-Chalmers as a machinist helper in 1924. During the next five years he worked in the company's field service and erection department.

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J. P. Kneubuhl

James P. Kneubuhl, assistant manager of sales for the Fluor Corporation, Ltd., Los Angeles engineering and construction firm, has also assumed the duties of district sales manager of the company's New York office. Kneubuhl joined the firm in 1941 as an assistant project engineer. In 1944 he became advertising manager, holding that position until 1946 when he joined the sales department. A graduate of Stanford, he also attended the University of Southern California.

Waif Strain, warehouseman and pump repairman at Lindsay, Oklahoma for Continental Supply Company has been transferred to Russell, Kansas as store manager. **N. K. Keller,** manager at Kermit, Texas was transferred to Snyder, Texas in the same capacity. **Conley H. Sims,** manager at Monahans, Texas has been transferred to Kermit in the same capacity. **Roy A. Henley,** floorman at Monahans, has been appointed store manager at the same location. **Tommy B. McClelland,** assistant store manager at Eunice, Louisiana has been made store manager there. **J. I. McQuiddy,** salesman at Kilgore, Texas has been transferred to Casper, Wyoming district office as manager of production equipment sales.

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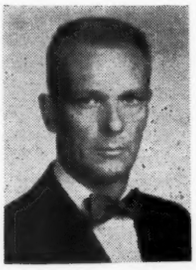
B. A. Main, Jr.

H. L. Schrock

Benjamin A. Main, Jr., was recently appointed vice president in charge of engineering for Aeroquip Corporation. A graduate of special courses of the University of Michigan, Main has been with Aeroquip since 1942. **H. L. Schrock, Jr.,** was appointed vice president and treasurer. He has been with the company since 1947.

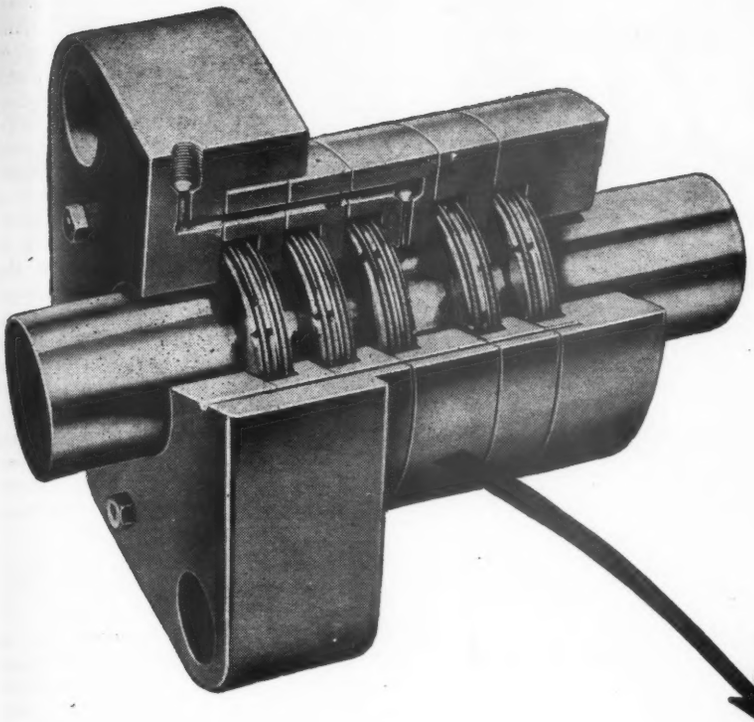
H. Gordon Smith, vice president and general manager of the textile division, has been named to the newly created post of executive vice president of the U. S. Rubber Company. The new position was created because H. E. Humphreys, Jr., has been called upon to do double duty as president and chairman. **William E. Clark,** assistant general manager of the textile division, has been elected a vice president and made general manager of the division.



J. G. Goodwille

J. G. Goodwille has joined A. O. Smith Corporation at Milwaukee, Wisconsin as industrial safety grating product supervisor. In this activity Goodwille will develop advertising and sales promotion programs for A. O. Smith safety grating, working through the firm's district sales organizations in New York, Chicago, Houston, and Los Angeles. Appointment of a product supervisor for A. O. Smith industrial safety grating implements plans to expand this phase of the company's manufacturing and marketing operations.

Kenneth T. Rudd has been elected treasurer, with headquarters in Cedar Rapids, Iowa, for Link-Belt Speeder Corporation. **Harry E. Kellogg,** who is vice president and treasurer of Link-Belt Company in Chicago, has previously served also as treasurer of Link-Belt Speeder Corporation. Rudd, a graduate of Indiana University, began his Link-Belt career in the Ewart plant accounting department at Indianapolis. For the last two years he has been assistant controller at the executive offices in Chicago. **Emery A. Freeman** continues as assistant treasurer and credit manager of Link-Belt Speeder Corporation, with headquarters in Cedar Rapids.



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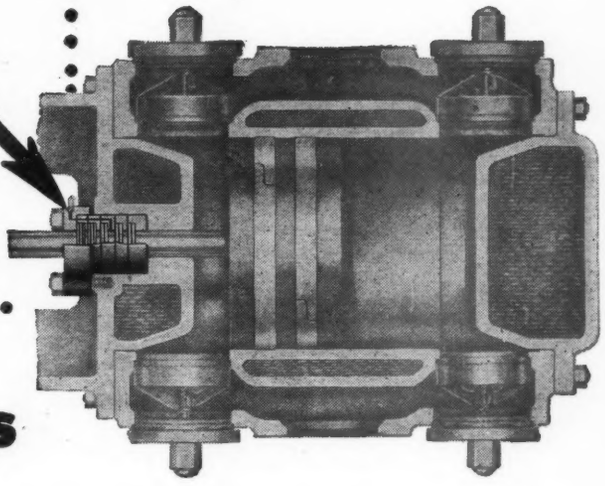

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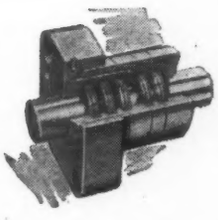

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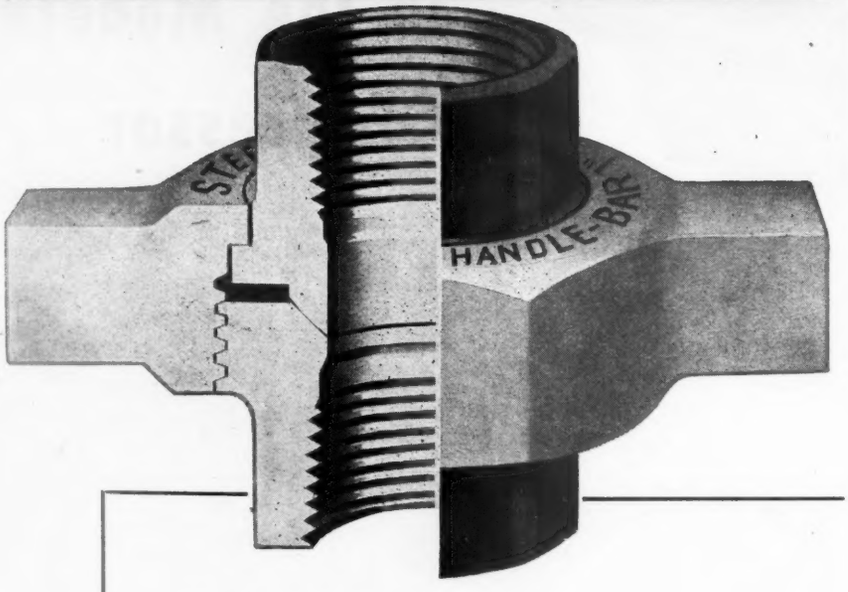

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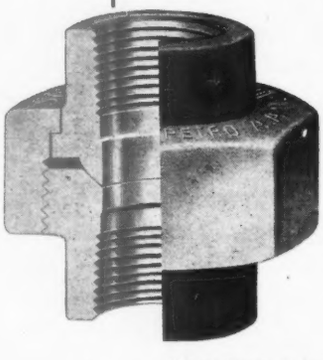

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H. V. Rasmussen

▸ **H. V. Rasmussen** has been appointed executive engineer at the Wellsville, New York plant of Worthington Pump and Machinery Corporation. Rasmussen was graduated with an M.E. degree from the Institute of Technology, Copenhagen, Denmark, in 1920 and did graduate work at the Massachusetts Institute of Technology. Well known in the steam turbine engineering field, he has spent a number of years with both the Westinghouse Electric Corporation and the DeLaval Steam Turbine Company. During World War II he was a consultant for National Defense Research at Columbia University, and a representative on the propulsion turbines and technical committees.

▸ **Robert G. Gertsmyer** has been added to the sales staff of Dearborn Chemical Company. He will cover North and South Carolina with headquarters in Charlotte, North Carolina. For the past three years, Gertsmyer has been a district sales engineer with Johns-Manville. Prior to this, he was with the Shell Oil Company and Wright Aeronautical Corporation. Gertsmyer attended Johns Hopkins University and has an M.B.A. in industrial management from the Wharton School of Commerce.

▸ **E. E. (Spike) Spicer** has been named Oklahoma sales representative for Baird Manufacturing Company, Tulsa, Oklahoma. Well-known throughout the Oklahoma and Kansas petroleum area, Spicer was formerly with the diesel division of the General Motors Corporation. He will devote his time exclusively to the promotion and sale of Baird oil field production equipment.

E. E. Spicer

▸ **W. J. Blackburn** has been named industrial manager of the Denver, Colorado office of the Minneapolis-Honeywell Regulator Company succeeeding **Donald W. Larcen,** who was recalled to active military duty. **Donald D. Baker** has been made industrial manager of the Kansas City office, succeeding Blackburn. Baker, formerly at Wichita, Kansas, has been replaced there by **Bernard J. Alberts** from New Orleans, Louisiana. **Jack F. Smith** has been appointed industrial manager at Tulsa, Oklahoma from which city he will coordinate the company's industrial sales activities in the Tulsa, Oklahoma City and Amarillo, Texas areas under the direction of **Reginald Walker,** branch manager. **Pilgrim McRaven** will handle industrial interests in Oklahoma City.

D. T. O'Connor

R. R. Chenault

D. T. (Mickey) O'Connor, New York City, representative of a number of drilling and pipe line specialty companies, has recently been appointed exclusive sales representative of Mud Products, Inc., Tulsa, Oklahoma, for eastern seaboard sales. O'Connor will also represent Mud Products, Inc. for export sales. He will handle the Mudco Butterfly valves, mud tanks, and ditches, manufactured by Mud Products, Inc. Associated with O'Connor is **Ross R. Chenault,** formerly with Trinidad Leaseholds, Ltd in Trinidad.

Hans A. Altorfer has been appointed chief engineer, Nordstrom Valve Division of Rockwell Manufacturing Company. He is a graduate of the Winterthur Institute of Technology in Switzerland where he received his engineering degree in 1928. Before joining the company, Altorfer spent five years as a designer of machine tools. He then joined Terry Steam Turbine Company and later worked for Allis Chalmers Manufacturing Company where he was principally engaged in the design and development of steam and gas turbines.

W. G. Pitezel

W. G. (Bill) Pitezel, sales coordinator of Franks Manufacturing Corporation of Tulsa, Oklahoma, has been appointed Oklahoma district sales manager, according to Carl White, Jr., president. Pitezel has been with Franks for the past 10 years, except for a three year period in the army air force. He has worked in the shop and in almost all departments of the sales division.

J. Chester Ray has been named executive assistant to the general manager of the United States Rubber Company. He began his career with U. S. Rubber as a stockroom boy in Pittsburgh, becoming manager of the Pittsburgh branch in 1922.

Wilson O. Green was named general sales manager, tire division. A graduate of North Carolina University, he joined U. S. Rubber in 1935. **Lawler B. Reevers** has been named sales manager, U. S. tires, succeeding Green. Green joined the company in 1941. **Thomas J. Newton,** former general service manager, tire division, was named assistant to the general manager. He has been with the test wheel and field service engineering department for 15 years. Newton is succeeded by **R. A. Blake,** who has been with the company since 1937. The new general service manager was formerly assistant general service manager.

Fred R. Grassle, secretary of Hills-McCanna Company, has been appointed assistant to the president. He retains his duties as secretary. **R. T. Kidde** has been appointed general sales manager of all divisions, according to C. A. Howe, president. Hills-McCanna Company has been in business for 81 years.

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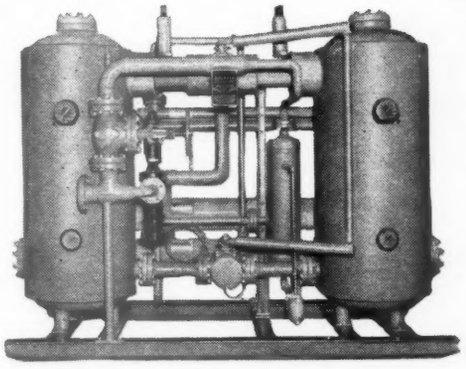

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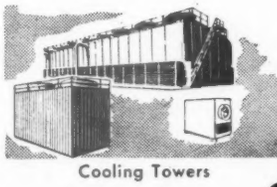

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▸ **C. E. (Neil) Thomas** has joined the sales staff of Chiksan Company, Brea, California, and has been assigned to Chiksan's eastern headquarters, 155 Washington Street, Newark, New Jersey. Previously, he was a sales representative for General Cable Corporation, covering the New York metropolitan area and New Jersey.

C. E. Thomas

▸ **Ray C. Green,** formerly with British American Oil Company, has been named district representative at Duncan, Oklahoma for Fluid Packed Pump Company. **Ray Housley** has been transferred from Eldorado, Kansas to Seminole, Oklahoma, and **Robert V. Holton** is now stationed at Eldorado, Kansas. **David Russell, Jr.,** formerly of the Oil Well Supply Company is the new district representative at El Dorado, Arkansas.

▸ **George Russell Carr,** chairman of the board of Dearborn Chemical Company, was honored at the company's annual 25-Year Club dinner recently for the completion of a half century of continuous service to the company. Carr joined Dearborn shortly after his graduation from the University of Illinois in 1901, beginning as a salesman in the railroad division of the company, and served successively as assistant general manager and general manager until 1922, when he was elected a vice president and general manager. In 1944 he was made chairman of the executive committee and then board chairman in 1945.

Acknowledgment of his 50 years with Dearborn will be made by E. M. Converse, senior vice president of the company and president of the 25-Year Club, with a gift presentation to be made at the banquet at the Sherman Hotel.

▸ **Harrison Johnston** has been appointed manager Ampex Electric Corporation's newly created product engineering division. Johnston will have his offices at the company's Redwood City, California, factory. Among his activities he will supervise the marketing of the Ampex Audio and Data Recorders. Johnston, an engineering graduate of Princeton University, has been associated with the General Electric Corporation for the past 12 years.

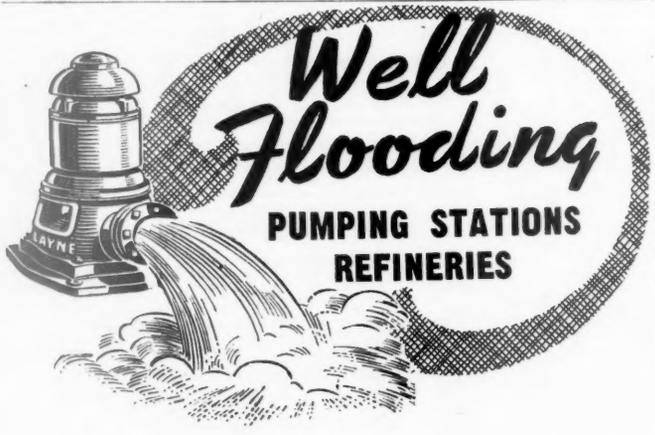
▸ **Wenzel A. Lindfors** has been named sales manager of the New York Belting and Packing Company. He will make his headquarters in the company's Passaic, New Jersey, plant. In his new capacity, Lindfors will direct all sales for company's line of industrial rubber products such as transmission, conveyor and elevator belting, water, air and gasoline hose, packing, etc.

▸ **R. J. Munn** has been named assistant sales manager of oil field products for Rockwell Manufacturing Company. After three years in the Army Air Corps, Munn studied engineering at Texas A&M College. Recently he has been working as a sales engineer of the Nordstrom valve division of Rockwell's Houston, Texas, district office, and before that was in charge of the Corpus Christi office for several years. Prior to joining Rockwell he worked as a roughneck in the oil fields and later was associated with Bethlehem Supply.

R. J. Munn

▸ **Forrest Lee Andrews** of the law firm Andrews, Kurth, Campbell and Bradley, Houston, Texas was elected to the board of directors of Plastic Coating Corporation, Houston.

▸ **Tom Billings** has been placed in charge of sales for the pipe line department of Thornhill-Craver Company. He has been a sales representative in the Houston territory since the first of the year. Before joining Thornhill-Craver, Billings was a petroleum engineer with the Gulf Oil Corporation. A native of Dallas, he is a graduate of the University of Texas. His headquarters will be in Houston, Texas.



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R. T. Harcus

J. B. Merritt

Robert T. Harcus, executive vice president and general manager of International Cementers, Inc. has been named assistant to the president of Byron Jackson Company. A graduate of the University of Edinburgh, Scotland, Harcus served with Byron Jackson from 1945 until 1947 when he joined International Cementers, Inc.

J. T. Workman

John B. Merritt, general manager of the Patterson Ballagh Division, will be general manager of International Cementers, Inc. Merritt, a graduate of the University of California, joined Byron Jackson in 1940. **James T. Workman** will replace Merritt as general manager of Patterson-Ballagh. Workman joined Byron Jackson in 1946. He is a graduate of the University of California.

H. V. Hughes has recently been appointed manager of the industrial division of Southwestern Engineering Company (SWECO). Among the activities included in this division are heavy industrial engineering and construction, with emphasis on metallurgical and chemical plants, heavy-media separation plants, and the SWECO Metallurgical laboratory.

Ralston B. Reid of Schenectady, New York, has been appointed an assistant manager of the advertising and sales promotion department of General Electric Company's apparatus marketing division. In his new position, he will coordinate activities of the department's five advertising sections, visual education section, and the company news bureau at Schenectady. Manager of inductrial advertising for the department from 1943 until his new appointment, Reid has served General Electric for the past 21 years.

Frank H. Webster has been appointed assistant manager western division, Chicago, Illinois, for Hyatt Bearings Division, General Motors Corporation, Webster joined the Hyatt organization in 1925 as a sales engineer in the Oakland, California office. In 1938 he was transferred to Chicago where he continued in the capacity of sales engineer, up to time of his new assignment.

J. J. Rosecky

J. J. Rosecky has been appointed general manager of the Torrance, California plant of the IDECO division, Dresser Equipment Company. Before joining IDECO division, Rosecky was vice president of manufacturing for the Heil Company of Milwaukee. He is a mechanical engineering graduate of the University of Wisconsin.

James Reed has been named development engineer in the service and product development department of Dowell Incorporated and **Roy Bostick** has been promoted to sales development engineer in the sales department in the Tulsa, Oklahoma offices.

Other changes include: **Paul S. Clinkenbeard** and **Dale Benefield** have been named district sales engineer and sales engineer, respectively, at Shreveport, Louisiana. Six employees in the Edmonton, Canada, office have received promotions. They are **William Stemp,** area development engineer; **Spence Lawrence,** office manager; **William Wedderburn** and **Lewis McCabe,** service supervisors, and **A. E. Thorson** and **Wallace Thorvaldson,** sales engineers.

Denison A. La Bauve has recently been promoted to field sales and serviceman at New Iberia, Louisiana, according to an announcement by J. P. Magoffin, sales manager, Patterson-Ballagh

D. A. La Bauve

division, Byron Jackson, Company. La Bauve has been with Byron Jackson since 1948, having his office in New Iberia, and handling Patterson-Ballagh products in that area.

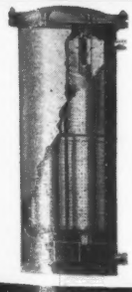
Harold W. Beder, Jr., has been named general sales manager of Whitney Chain Company, Hartford, Connecticut. He was formerly associated with McKinsey Company, management consultants, New York, as market research specialist. He was formerly with Proctor and Gamble as a member of their marketing division. Prior to this, he was the owner and publisher of a magazine devoted to gardening. Earlier, he was merchandising manager for John Wanamaker.

H. W. Beder, Jr.

B. V. Nordberg

Bruno V. Nordberg has been named sales engineer, four-cycle engine department. heavy machinery division, Nordberg Manufacturing Company, Nordberg attended the University of Wisconsin and Marquette University. In 1946 he joined Nordberg and was assigned as a test and erection engineer in the heavy machinery division.

HILCO LUBE AND FUEL OIL PURIFICATION FOR DIESEL AND GAS ENGINES . . .



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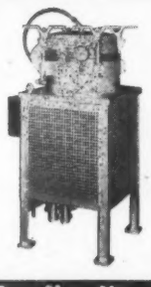

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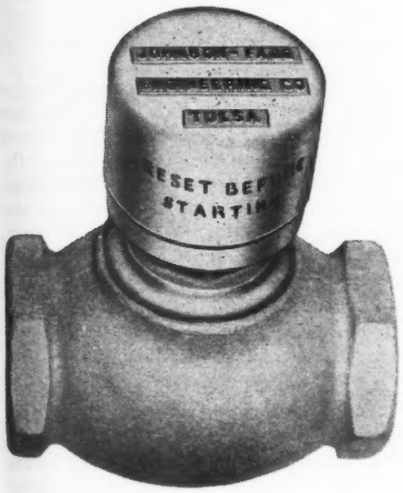
New Machinery and Supplies

Use reply card to procure promptly complete information and prices of products described here in brief.

Circle corresponding letter or letters on reply card.

(A) SWITCH VALVE

A newly developed automatic cut-off switch valve for recycling units stops the prime mover when the stock tank is empty. This eliminates the necessity for the lease pumper to return and shut



down the unit. When the fluid flow ceases, because of pump failure, belt failure, or if the intake or discharge line plugs up or is cut off, the switch-valve will automatically shut down the prime mover. Two electrical terminals are provided on the switch valve, which make it possible to hook up the circuit to ground the magnito on an engine or operate a relay to cut off an electric motor. Johnson-Fagg Engineering Company.

Circle letter (A) on reply card.

(B) POWER UNITS

Two new hydromotor power units, first ever to be installed on a Nordstrom valve, were placed in service at Michigan-Wisconsin's new compressor station, at Woodstock, Illinois, on the Wisconsin branch of Michigan-Wisconsin Pipe Line Company's new 22-in. line from Oklahoma to Big Rapids, Michigan and Fon Du Lac, Wisconsin. The valve is the result of five years research by Jack Shafer of the Shafer Valve Company of Mansfield, Ohio, designer and patent owner. Officials from various companies witnessed the unit's first test.

Circle letter (B) on reply card.

(C) DYNAMIC BALANCER

The Wagner Universal dynamic balancer is a new machine that provides a simple method of putting armatures, rotors, pulleys, flywheels, gears, hubs, drums, etc. in true dynamic balance. The part to be balanced is placed on the balancer with shafts resting on ball-bearing rollers and then rotated to determine the position of dynamic unbalance so that corrective weights can be added. The driving mechanism consists of an arm with a set of five V-belts driven by a 5 hp motor. Balanced to stand in up position normally, it is lowered by the operator until the belts touch the equipment to be rotated. While rotating, the shafts are marked with pencil or crayon. Because unbalance causes the shaft to rotate off center, the markings will appear on one side thus showing where weights should be added.

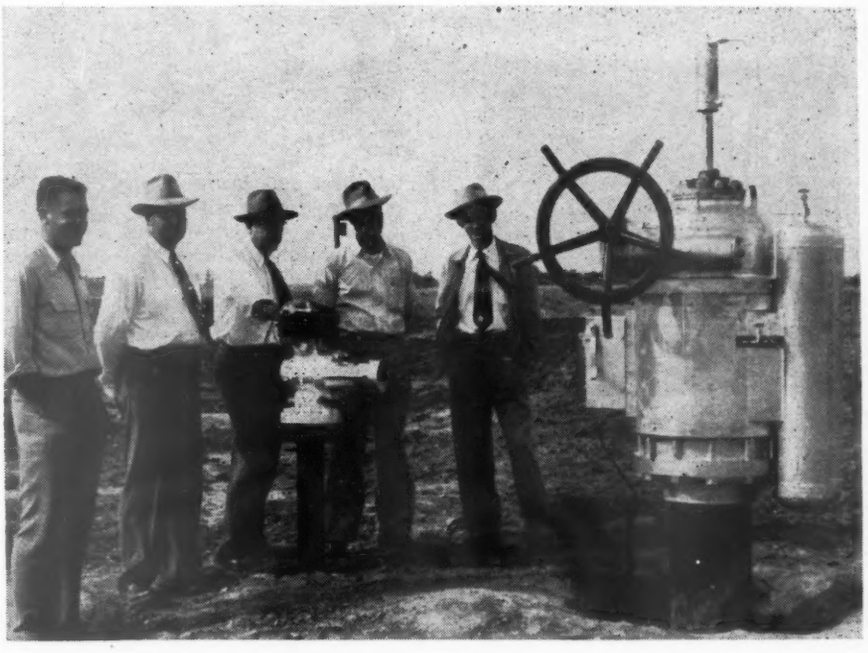
Circle letter (C) on reply card.

(D) BULLDOZER

Development of a big-capacity, no-pushbeam bulldozer, is announced by The Baker Manufacturing Company. This new unit embodies the first radical change in industrial dozer design since Baker pioneered the hydraulic control Bulldozer in 1926. Designated the 9-X, this new dozer, by elimination of push beams, mounts an 8 ft blade on the 70-drawbar horsepower 9-ton Allis-Chalmers HD-9 Tractor. Incorporating the Baker "Roll-Action," this narrower blade has approximately the same total blade area and capacity as the conventional 9 ft 6 in. model for the HD-9 Tractor. The new dozer is designed especially to meet the varied requirements of oil-field use. It is extremely versatile because of its day-or-night portability, its steep in-and-out efficiency, and its narrow width. Baker Manufacturing Company.

Circle letter (D) on reply card.

Jack Shafer, inventor of a new hydromotor valve; Bill Clark, division superintendent of Michigan-Wisconsin Pipe Line Company; G. M. Kirkpatrick, sales representative for Bradshaw Company; Harold Harris, compressor station superintendent, and Ray Biddle, expeditor for Texas Eastern Pipe Line Company, witness the first full test of the new valve.



(E) ELECTRIC PLANT

A new 3000-watt diesel electric plant, powered by an air-cooled full-diesel Onan engine, is announced by D. W. Onan and Sons, Inc. Simplified plant design makes it possible for anyone to operate and service this Model 3DSP-1E diesel unit. Push-switch control for electric cranking, manual compression release, and an electrically heated glow-plug for cold weather starting are provided. The plant is driven by a four-cycle single-cylinder Onan DSP diesel engine.

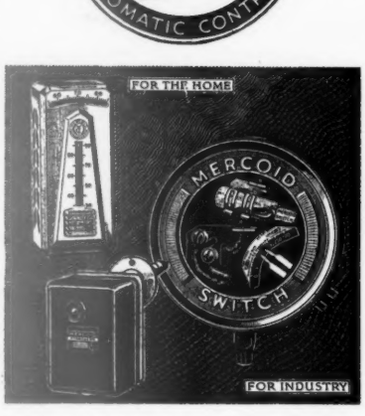
Circle letter (E) on reply card.

(F) SCREW VISE

A universal screw vise called the Sevo vise that instantly clamps round, tapered, or irregular objects has just made its appearance on the market. Its jaws consist of a series of machined and ground flat plates, which hinge or swivel in any desired direction to coordinate with the shape of the held object. These jaws are so designed that they can be moved in relation to each other, and the work piece can rest on a contact surface underneath. By turning the main screw the locking jaws position themselves and can then be locked to retain their directional position. Unlike conventional vises, the tightening screw requires only a slight turn, without imposing a heavy torque, to tightly grip the object.

Circle lettter (F) on reply card.

MERCOID



THEY ARE USED FOR THE CONTROL OF TEMPERATURE, PRESSURE, LIQUID LEVEL AND MECHANICAL OPERATIONS.

THE MERCURY SWITCH IS A FEATURE IN MERCOID CONTROLS. THE REASON FOR THE MERCURY SWITCH IS THE ADDED SAFETY, BETTER PERFORMANCE AND LONGER CONTROL LIFE—ALL OF WHICH ARE IMPORTANT WHEREVER CONTROLS ARE REQUIRED. WHY CONSIDER LESS WHEN YOU CAN GET SO MUCH MORE

WRITE FOR COMPLETE CATALOG

THE MERCOID CORPORATION
4201 BELMONT AVE. CHICAGO 41, ILL.

(G) RUBBER SEALER

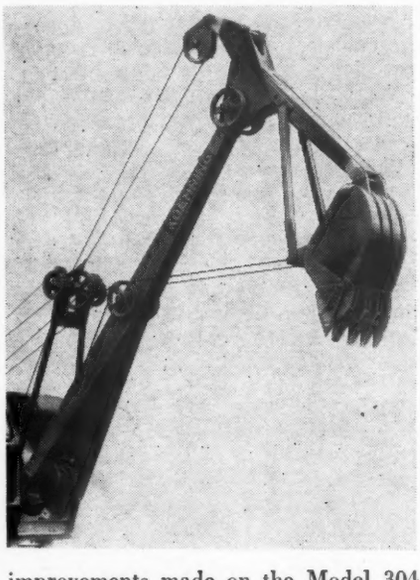
To seal off tremendous pressures that may leak around the threads in oil well tubing, a small dam type seal made of Hycar oil resistant rubber has been devised by the Bert L. Stone Engineering Company. The chief source of leak in oil well tubing is a spiral leak in the threads. All threads are made with a small clearance between the root or valley of one thread and the crest of the mating thread, thus providing a very small channel the full spiral length of the thread. Oil or gas washes the "thread dope" out of this channel to start a small leak that becomes a major leak as the metal is cut away.

Called the "Stoneseal," the new type dam seal is approximately the size of an eraser on a common lead pencil. In installation a hole is drilled completely through the oil well tubing to allow gas pressure from the inside of the tubing to force the Hycar rubber seal into the thread of the coupling. Bert L. Stone Engineering Company.

Circle letter (G) on reply card.

(H) HOE ATTACHMENT

A newly designed hoe attachment for the Koehring 304 excavator will increase the machine's digging depth to 19 ft, 9 in., according to a recent announcement by the manufacturer. Other

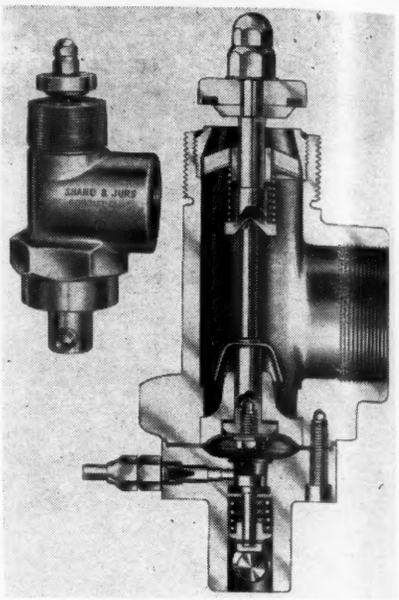


improvements made on the Model 304 provide extra resistance to side sway and extra strength to meet any operating condition for below ground level excavating. Officially rated as a ¾ yard excavator, the 304's sturdy dipper arm is pivoted at the end of the boom and jackknifes to dig a vertical backwall. Koehring Company.

Circle letter (H) on reply card.

(I) SAFETY VALVE

Shand & Jurs Company are now manufacturing and marketing a new internal safety valve for LP-Gas truck tanks, according to a recent announcement. It is "Safetiflo," developed jointly with the Phillips Petroleum Company. The valve is installed in the tank outlet, with shut-off valve seat inside the tank shell. A 5/16-in. copper tube or pilot line is connected from the discharge



side of the pump to the pilot side of a diaphragm in the valve body. The first time the valve is to be used, it is primed manually. When the pump is started the discharge pressure transmitted through the pilot line exerts its effect on the diaphragm forcing the "Safetiflo" open. The "Safetiflo" valve is unique in that it utilizes LP-Gas pressure for fully automatic operation.

Circle letter (I) on reply card.

(J) FACING ROD

Wall Colmonoy Corporation announces a new hard facing rod—wallex. Wallex is an oxy-acetylene hard facing rod for abrasion resistance with good impact and corrosion resisting properties.

It is made of chromium, molybdenum, manganese, silicon, carbon, and iron. It possesses excellent weldability—a quality developed after years of research on the part of Wall Colmonoy Corporation metallurgists.

Circle lettter (J) on reply card.

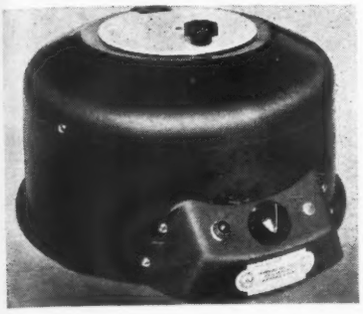
(K) RELIEF VALVE

The Andrews-Alderfer Processing Company, Inc., has announced the availability of the new type A-120 relief valve that features positive, accurate control on 2 psi air pressure and large volume exhaust at 3 psi pressure. Originally developed for use on inflatable rubber boats, the new low-pressure valve has been engineered for end uses involving specifications too exacting for conventional type relief valves. In addition, A-120 has check valve characteristics because it permits only a one-way flow. Recommended for applications in which accurate pressure control of air or gases is vital, ANDAL A-120 valve is 1⅛ in. high and 7⅜ in. in overall diameter. The Andrews-Alderfer Processing Company, Inc.

Circle letter (K) on reply card.

(L) CENTRIFUGE MACHINE

A unique compact centrifuge machine has been developed by W. L. Walker Company. For accurate measurement of BS and water content, the new Walker centrifuge now features a combined



rheostat and switch with safety pilot light. Speeds are adjustable up to 2450 rpm (required API speed—1750 rpm). Six volts and five and one-half amps make it easy on the car battery. Easy to install in the gagers car, the centrifuge now occupies less space. All aluminum construction makes it lighter and of non-sparking material. The tube head is numbered to aid ready identification of samples.

Circle letter (L) on reply card.

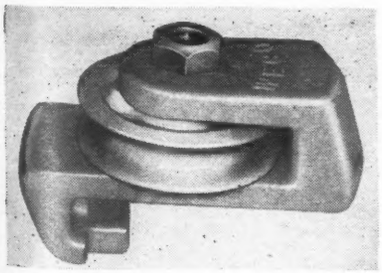
(M) PROTECTIVE COATING

Coal tar pitch has been compounded by a recently developed process into a fast drying protective coating by breaking it down into minute molecules, then combining it with water and a stabilizing emulsification agent to form a permanent suspension that can be brushed or sprayed. Available under the trade name "Tarlac" this new coating is said to retain all the excellent protective and adhesive qualities of coal tar pitch, to be impervious to oils, greases, other petroleum derivatives, acids, alkalis, water, and condensation. It will not crack at low temperature or run at high temperature. Good from —56 to 200 F.

Circle letter (M) on reply card.

(N) SIDE LINE BLOCK

A specially designed block that hooks onto the back corner of a truck bed has been announced by Well Equipment Manufacturing Corporation. The out-



standing advantage of this block is that it permits pulling-in or shifting a load at right angles to the truck without looping the line under the corner of the truck bed or resorting to makeshift methods of attaching a snatch block. The side line block lies flat on the bed of the truck, with the hook or tongue, hooked into slots that have been cut into the side of the truck frame. It can be used on either side of the truck. When the block is in position, the line can be laid over the sheave.

Circle lettter (N) on reply card.

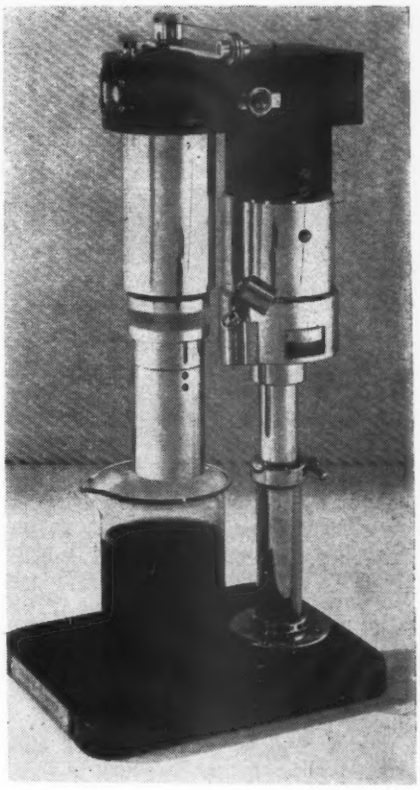
(O) BRIDGE FLOORING

Kerlow Steel Flooring Company has developed a new steel bridge flooring, called the IQ-35 rectangular flooring. IQ-35 is made with grating parallel with traffic and transverse to traffic. In the latter type, the transverse bars that the tires ride on are placed higher than the longitudinal bars, and the transverse bars are serrated to enable tires to maintain or to develop greater traction for emergency stopping. This important safety measure, together with the balanced construction of the grating, establishes IQ-35 as the safest and the strongest flooring per unit of weight that Kerlow Steel Flooring Company has ever manufactured.

Circle letter (O) on reply card.

(P) VISCOSIMETER

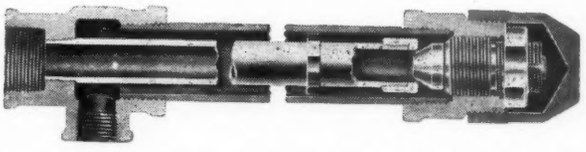
Geophysical Machine Works announces its new multi-speed, portable viscosimeter. It is called the Fann V-G meter; weighs only 9 lb, and may be operated from a 6-volt car storage battery. It is a rotational type instrument with five speeds, electrically driven, permitting sustained rates of shear for any desired period of time. Its measuring system employs a motor driven outer cylinder concentric with a stator. The



fluid being tested occupies the annular space between the two, and exerts a torque on the stator that is proportional to fluid viscosity.

Circle letter (P) on reply card.

NOT 1 CENT for Repair Parts for 444 Nicholson Steam Traps Installed in 2 Years



Pressure: 0 to 250 lbs. without change of valve or seat. Length: 9" to 40", 2 types: thermostatic, continuous flow.

Here is added evidence of the remarkably low maintenance costs of Nicholson expansion steam traps. In the 2 years Bradshaw & Co. have been distributing them in the Pittsburgh area they have installed 444 traps. But they have received not one order for repair parts. And examination of traps in continuous drainage service for at least 18 months, at steam pressures to 250 lbs., showed no sign of valve cutting.

Easily Installed, Low Cost

Because valve is easily adjusted to pass condensate at any temperature below 212° F., these traps are also widely used for regulating temperature of equipment.

FOR ALL EQUIPMENT Using Steam or Hot Water

Agitators	Radiators
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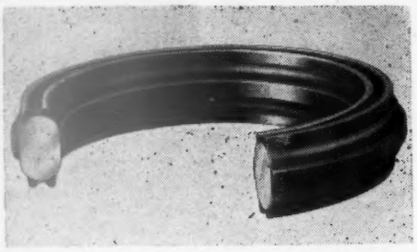
Kettles	Washers
Pipe Coils	Water Stills

CATALOG 751 or see Sweet's

W. H. NICHOLSON & CO., 217 Oregon St., Wilkes-Barre, Pa.

(Q) RING JOINT GASKET

Petroleum Mechanical Development Company has announced the development of a new "Flex-Tip" ring joint gasket. The unit will be manufactured in all sizes used in well control for pressures of 2000 psi and above. The design of the new ring embodies two independently acting seals. The first sealing mechanism is the standard A.P.I. metal to metal seal acting exactly as in the standard gasket. The Flex-Tip mechanism uses the interference principle of sealing in a manner similar to that of the common "O" ring. A new compound not previously available has been employed to give resistance to chemical reagents commonly found in connection with drilling for or producing petroleum. The Petroleum Mechanical Development Company.



Circle letter (Q) on reply card.

(R) CONTROL SYSTEM

A new automatic all-electronic instrumentation and control system for use in chemical and food processing plants, refineries, petrochemical installations, industrial power plants and central stations is announced by The Swartwout Company. Known as the Swartwout Autronic control system, it has been under development for several years and was publicly displayed for the first time at the recent Sixth National Instrument Exhibit at Houston. The Autronic control system consists essentially of three basic units: Primary sensing element, Autronic control unit, and final control element. The system is powerd by 115-volt, 60-cycle alternating current.

Circle letter (R) on reply card.

(S) AIR CLUTCH

National Supply Company's new drum type air clutch, the Ideal Dy-A-Flex, is now standard equipment on five drilling rigs in one to three positions, it is announced. Five of the National Ideal Consolidated drilling rigs, the 50-A, 75-CA, 80, 100 and 130, have the Dy-A-Flex clutch on the high drum drive. Simplicity and minimum maintenance are the outstanding features of the Dy-A-Flex clutch. Friction shoes are independent, removable assemblies designed for induced cooling by air circulation through light metal construction. They can be removed individually and need not be disassembled for lining replacement.

Circle letter (S) on reply card.

(T) SYSTEM MONITORS

An electronic scanning system designed to automatically and continuously monitor up to 270 separate processing temperature points has been developed by Minneapolis - Honeywell Regulator Company. "The new system," said Honeywell's engineers of the Brown Instruments Division, "records only those temperatures that deviate beyond a pre-set limit. It includes an audible alarm that permits immediate correction of excess temperatures, and replaces the cost and use of several instruments and time-taking logging operations and maintenance."

Circle letter (T) on reply card.

(U) METERING PUMPS

Mechanical Products Corporation has new Maisch line of small metering pumps of fixed and variable capacity for dispensing controlled volumes of hot or cold, viscous or non-viscous liquids with smooth, non-pulsating flow. Maisch metering pumps are precision built; floating stainless steel gears permit close running tolerances within a self-lubricating carbon housing. Pump heads are quickly demountable and sterilizable.

Circle letter (U) on reply card.

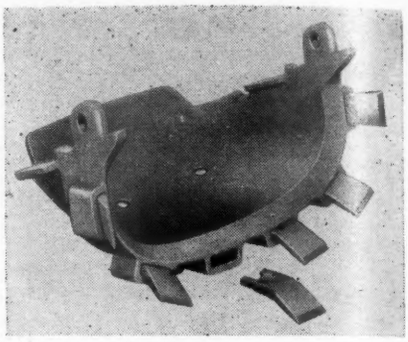
(V) FLARE BURNER

Smokeless burning of large volumes of disposal gases along with low steam consumption and high resistance to heat damage are the features of a new field flare burner designed by John Zink engineers. The new flare is for use in refineries, gasoline plants, chemical plants, sewerage disposal plants, and other facilities where excessive volumes of gases must be burned as a means of disposal. It is made of heat resisting alloys and employing a new method for cooling of the burner parts in combination with completely stable piloting, it winds up to 80 miles per hour.

Circle letter (V) on reply card.

(W) BUCKET TOOTH

The development of Tap-In bucket teeth as standard equipment on all Trenchliners has been announced by the Parsons Company. Principal feature of the newly designed, self-locking tooth is the "easy-in, easy-out" time saving replacement involved. Tap-In teeth eliminate the need for bolting or crimping edges to hold teeth in position. A precision fit taper locks the tooth firmly in place either on buckets or sidecutter bars. Sturdy tooth holders are integrally cast with the bucket lip for positive tooth support. By welding adapters to the buckets, Trenchliners of any age can be converted to use Tap-In teeth.

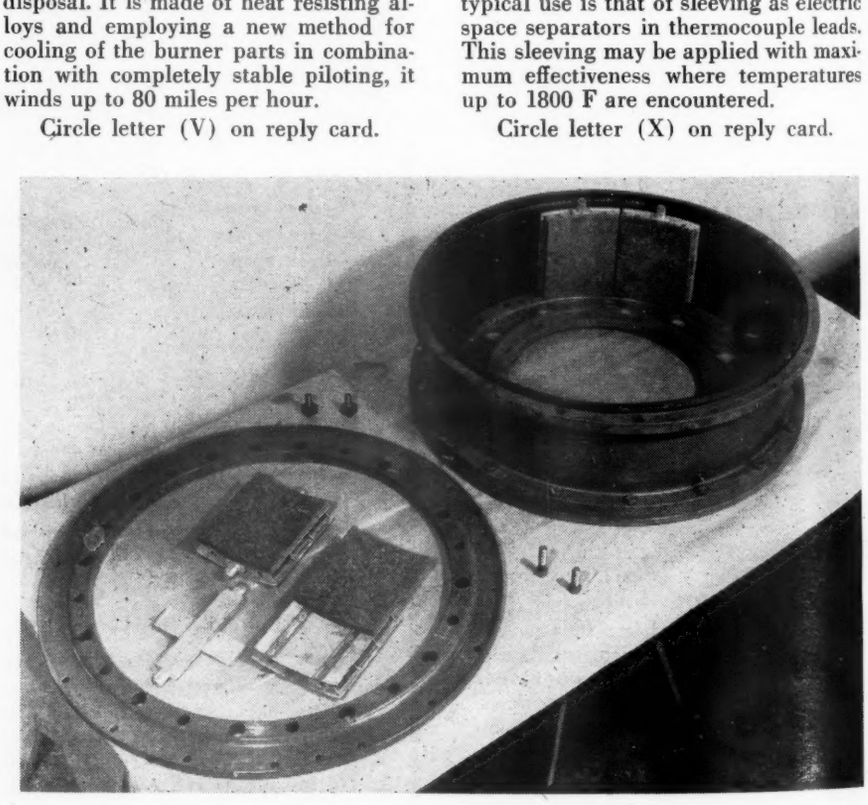


Circle letter (W) on reply card.

(X) INSULATION

A fibrous silica insulation, Refrasil, was developed by H. I. Thompson Company for installation in jet aircraft. Today, the versatility of Refrasil is being demonstrated by application to thermal and electrical insulation problems in petroleum chemistry, electronics, etc. A typical use is that of sleeving as electric space separators in thermocouple leads. This sleeving may be applied with maximum effectiveness where temperatures up to 1800 F are encountered.

Circle letter (X) on reply card.



National Supply's new drum type air clutch.

Trade Literature

Publications will be sent free.

(Y) ELECTRIC WELDING

The Tweco Products Company has issued a 12-page booklet No. 8 Twecolog illustrating and describing the complete line of Tweco electrode holders, ground clamps, cable connectors, terminal connectors, cable splicers, mechanical and solder type cable lugs, carbon electrode holders, and the new "lug-set" block and punch for attaching solder type lugs to cables without solder. It also contains information about the care and maintenance of welding cables and connections.

Circle letter (Y) on reply card.

(Z) CLARK PRODUCTS

"How the Products of Clark Serve Industry" is the title of a new 32-page booklet, which illustrates and briefly describes the products of Clark Equipment Company. Profusely illustrated, this 3-color booklet shows a number of Clark axles and transmissions for trucks and buses, the unique, one-piece forged Clark axle housing, combination axle-transmission drive units for farm tractors, road and earth moving machinery and gears and forgings. Also described and illustrated is the broad line of Clark industrial towing tractors, fork-lift trucks and attachments, powered hand trucks, etc.

Circle letter (Z) on reply card.

(AA) ENGINEERING DATA

Design, operation, and engineering data on the Nordberg Supairthermal engine are presented in an attractive 12-page bulletin published by Nordberg Manufacturing Company. Bulletin 191 describes how the Supairthermal engine achieves its ability to produce, in any given size, one-third more horsepower than the conventional turbocharged engine. This is illustrated by indicator diagrams and a comparison the engine and piston strokes of a Supairthermal. The booklet also contains diagrams of the more common types of cooling systems applicable to the Supairthermal engine and presents a nomogram for determining the BMEP rating for the engine under typical operating conditions.

Circle letter (AA) on reply card.

(AB) TEMPERATURE CHART

Recommendations for correct field treatment—heating, dressing, and, hardening of Acme cable tool bits, alloy or carbon, are available on a temperature chart published by Acme Fishing Tool Company. The heat-color, hang-up chart, gives correct instructions to facilitate dressing. Data are divided into six headings — the forge, dressing heat, dressing hints, normalizing, hardening, drawing temper—for hard formations.

Circle letter (AB) on reply card.

(AC) TRANSMITTER

The Hagan flow signal transmitter, recently announced, is described in a new bulletin. This pneumatically operated pressure-differential measuring unit transmits proportional signals to remote recording or indicating instruments, or to automatic control elements. The signals may be linear with flow or linear with pressure differential. Diagrams in the bulletin illustrate seven suggested uses of the transmitter in measurement of flow, liquid fuel, liquid level, and absolute pressure. Flow applications include measurement of steam output from a boiler, superheater or evaporator; of feedwater flow to a boiler; of liquid flow through pump units; and of gas, vapor or liquid flow in process systems. Hagan Corporation.

Circle letter (AC) on reply card.

(AD) RECORDING MACHINE

The 5-114 recording oscillograph, a multi-channel, precision instrument for the analysis and measurement of strain, vibration, pressure, acceleration and other phenomena, is the subject of a fully illustrated technical bulletin just published by Consolidated Engineering Corporation. Highly compact and versatile, this instrument records photographically up to 18 separate, static or high-frequency phenomena simultaneously at record speeds of ½ to 115 in. per second. It also records timing lines at 1/100th-second intervals so that each phenomenon can be interpreted not only in relation to others but time.

Circle letter (AD) on reply card.

(AE) DRIVESHAFTS

A new bulletin on Morse Morflex radial and universal driveshafts is available from Morse Chain Company. The bulletin gives complete data and specifications on Morflex radial driveshafts with spline-jointed tubular shafts; Morflex universal driveshafts with one-piece tubular shafts; and Morflex universal driveshafts with spline-jointed tubular shafts. It also provides a working table of recommended lengths and speed.

Circle letter (AE) on reply card.

(AF) ARC WELDS

A pocket size booklet "Hobart Welding Electrodes and Weldors' Vest Pocket Guide," containing useful arc welding information, is now available from Hobart Brothers Company. This handy booklet gives information on metals and electrodes, types of electrodes, 4 essentials of proper welding procedures, color marking for identification of electrodes, types of joints, etc., plus handy reference information, and complete information and instructions for using all Hobart electrodes.

Circle letter (AF) on reply card.

(AG) HIGH NICKEL ALLOY

A new, 44-page booklet on the fusion welding of nickel and the high nickel alloys has just been published by The International Nickel Company, Inc. It includes more than 30 tables and almost 50 drawings and photographic illustrations. A complete technical treatise on the subject, it covers various forms of electric arc welding as well as gas welding. There are more than 20 chapters and sections covering, in addition to detailed welding instructions, such information of importance to production and welding engineers as the boiler code of the American Society of Mechanical Engineers, pickling, testing and inspection safety methods, etc.

Circle letter AG) on reply card.

(AH) EARTHMOVING TOOLS

Hydraulic and cable-controlled earthmoving equipment manufactured by Baker Manufacturing Company to match Allis-Chalmers Crawler Tractors is described in Baker Bulletin No. 895, just released. Baker attachments designed to work with A-C Tractors described in the bulletin include the engine-mounted hydraulic control bulldozers, gradebuilders, and root rippers (for the HD-5, HD-9, HD-15 and HD-20), and the three cable control units (for the HD-9, HD-15 and HD-20).

Specifications are listed showing at a glance the moldboard height and width, height of lift, depth of cut, degree of tilt, weight of blade and mounting, and overall length of tractor and blade, for all models.

Circle letter (AH) on reply card.

(AI) "HOW BOOK"

A 24-page booklet entitled "The How Book of Cost Cutting Materials Handling" is now available from the Philadelphia division, Yale and Towne Manufacturing Company. A revised edition of a previous booklet printed in 1947, the "How Book" was prepared under the guidance of Dr. V. S. Karabasz, Professor of Industrial Management, Wharton School, University of Pennsylvania. A large portion of the "How Book" is concerned with basic background material covering type of skids, pallets, and other industrial handling tools.

Circle letter (AI) on reply card.

(AJ) PUMPING UNITS

A 10-page booklet describing the Axelson hydraulic long stroke pumping unit was published recently. The 2-color booklet is profusely illustrated with charts and diagrams, with a considerable amount of reading material. Five actual case histories of use of the Axelson hydraulic pumping units are included. Diagrams describe the operating cycle of the Axelson unit and a list of specifications are given. In the back are two pages, which may be filled out by the individual company and sent in to the Axelson engineering department. This department will develop specific recommendations for consideration of the company.

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(AK) PUMP DRIVES

An 8-page bulletin describing the Pacific-Western right angle vertical pump drives may be obtained from the company. The drives are produced for the specific application of horizontal-type prime movers to vertical shaft pumps. They are designed and manufactured to cover a wide range of power and speed requirements, including all sizes larger than 200 rated horsepower at 1:1 ratio and 720 rpm. These pumps are designed for 24-hours a day continuous duty in pumping service at rated load under normal operating conditions. The 2-color booklet contains charts, pictures and diagrams to fully illustrate the uses and applications of the vertical pump drives. Western Gear Works.

Circle letter (AK) on reply card.

(AL) STORAGE TANK

The Diaflote, a new development in liquid storage tanks, is fully described in the Hammond Iron Works Bulletin 51 DF. The unique construction feature of the Diaflote is a Vulcalock membrane, attached to the inside periphery of the tank, which rests on the surface of the stored liquid to act as a barrier between the liquid and the air in the tank and prevents the formation of vapors. This membrane eliminates breathing and filling losses; prevents contamination or dilution of high purity products; excludes air from the deaerated products, and decreases corrosion.

Circle letter (AL) on reply card.

(AM) JOINTS, BELLOWS

A new catalog containing over 78,000 possible combinations of bellows type expansion joints has recently been published by the Solar Aircraft Company. It also contains a complete line of aircraft bellows and assemblies. This new 40-page catalog serves as a reference handbook and it illustrates a diversified line of standard and special bellows assemblies used to take up expansion, contraction, and offset movements in pipes and conduits. Several unique designs developed by Solar are described in this catalog, as well as many unusual types of bellows applications for the purpose of absorbing motions resulting from pressure or temperature changes in the conducted gases and liquids.

Circle letter (AM) on reply card.

(AN) VACUUM BREAKERS

Minneapolis-Honeywell Regulator Company has published a data sheet describing its vacuum breakers, which are used to protect valuable equipment such as tanks, boilers, reactors, stills, and other closed vessels from the damaging effects of a vacuum build-up. Specification sheet 413-1 fully describes these devices giving pertinent data as to sizes, construction, operating pressure, and relief capacity.

Honeywell Specification Sheet 408-2 which is also available describes the Series 700LF diaphragm motor valves, specifically designed for use in pilot plants and other applications where low flows are met and where wide proportional band control systems are needed. The sheet gives pertinent specification data such as sizes, inner valve types, etc.

Circle letter (AN) on reply card.

(AO) PROCESS SERVICES

The 1952 edition of "BS&B in the Process Industries" is now available. The 20-page, 2-color catalog is filled with illustrations and descriptive material on BS&B's special fabrication services, immersed coil and direct fired heaters, bolted and welded steel tanks, walkways, and stairways. An expanded section on control equipment includes diaphragm control valves, displacement type liquid level controllers, pressure controllers, drainers, self-operated and relay regulators, safety heads, and pressure-vacuum vent valves with flame arrestor units. Black, Sivalls and Bryson, Inc.

Circle letter (AO) on reply card.

(AP) HIGH TEMPERATURE

The development and research division of International Nickel Company, Inc., is offering data from its files on high temperature applications of metals and alloys. These files cover service records and results of plant and laboratory tests. They are not limited to nickel alloys but include quantitative data on many other materials, both wrought and cast. The division has prepared a Work Sheet, or questionnaire, designed to facilitate inquiries on specific high temperature problems to which answers can be found in these files.

Circle letter (AP) on reply card.

(AQ) PRODUCTS SUMMARY

The Pittsburgh Coke and Chemical Company has compiled a summary of the principal products of five of its divisions in a new booklet entitled, "Pittsburgh Chemicals". The 12-page letter-size bulletin lists important uses and applications of the products and, whenever possible, their specifications. There are sections devoted to the company's coal chemicals, plasticizer, activated carbons, protective coatings, and agricultural chemicals divisions.

Circle letter (AQ) on reply card.

(AR) PIPE COUPLING

A new style compression pipe coupling that practically eliminates turbulence at the joint is being manufactured by the Morris Coupling and Clamp Company. The new coupling is described in detail in a 4-page bulletin available free of charge to coupling users. The coupling is made up of three parts: 1) a gasket made of the material best suited to give protection for the specific job application, 2) steel inner sleeves with precision die-cut teeth placed eccentric to the gasket teeth to form a complete seal when the outer shell is tightened, and 3) steel outer shell made of zinc coated steel or corrosion resistant metals when required, with zinc-coated washers, bolts and nuts.

Circle letter (AR) on reply card.

(AS) CAST IRONS

A 36-page bulletin describing 8 types of austenitic nickel alloy cast irons that offer unique combinations of properties may be obtained from the International Nickel Company, Inc. Applications and comparative service data in many industrial fields are presented to prove its utility in withstanding corrosion, heat, wear, and low temperature. It serves as a reference booklet, well illustrated with photographs, tables of properties, and corrosion data on nearly 400 conditions.

Circle letter (AS) on reply card.

(AT) HIGH VACUUM EQUIPMENT

Research Vacuum Supply Company has just issued a 40-page, illustrated catalog listing research high vacuum equipment, high vacuum pumps and oils, gages, glass working machinery; including a full line of hand fires, torches, and blast burners. Needlepoint burners and accessories, cross-fires, and miscellaneous supplies for glass blowing, are also featured.

Circle letter (AT) on reply card.

(AU) LEVEL GAGES

An 8-page booklet featuring Jerguson Gage and Valve Company's remote reading gages is complete with reading matter, pictures, diagrams, charts, and other illustrative material. The Jerguson Truscale gages bring the liquid level readings down to the eye-level. They indicate changes in level by means of a special magnetic coupling drive, which causes a pointer to follow corresponding changes of the mercury level within a manometer. The use of a permanent magnet makes its operation entirely independent of any power supply.

Circle letter (AU) on reply card.

(AV) SELF-PRIMING PUMP

Bulletin No. 110 published by Carver Pump Company illustrates and describes the various sizes and types of pumps. The Carver self-priming pump has fast automatic prime, high suction lift capacity to handle more water, muck, solids, faster and easier. The company claims one of the outstanding features of the Carver pumps is the long-life mechanical seal with wearing surfaces almost diamond hard. Each model of the Carver pump is illustrated in the bulletin, giving the AGC rating.

Circle letter (AV) on reply card.

(AW) FOAM TOWER

The Pyrene Manufacturing Company has a new bulletin available titled, "Easy to Reach." The booklet describes the Pyrene portable foam tower for discharging fire-smothering foam onto the surface of burning oil in storage tanks. The foam tower is assembled in two separate sections—a rectangular frame base and a telescoping ladder or tower section on which are mounted a foam column and pouring head. It is constructed principally of aluminum. The tank is described in greater detail in the bulletin, plus charts and pictures.

Circle letter (AW) on reply card.

(AX) COPPER BASE ALLOY

The word "brass" as it is commonly used covers a very wide range of several hundred copper base alloys, each of which has differences and particular advantages. To help distinguish between copper base alloys, the Bridgeport Brass Company has published a new four-page folder which lists 65 commonly used Bridgeport brass and copper alloys, along with their composition, properties, forms, and typical uses.

Circle letter (AX) on reply card.

(AY) TRACTOR-SHOVEL

A new catalog has just become available covering one of the newest of the Hough Payloader tractor-shovels known as the Model HY. Many action views are used showing how this 1¼ cu yd capacity machine is serving the construction and public works fields. Features such as full-reversing transmission, operator visibility and safety, full hydraulic bucket control, and power booster steering, are illustrated. The Frank G. Hough Company.

Circle letter (AY) on reply card.

(AZ) PACKING SEALS

The Durametallic Corporation has published a 4-page, 2-color bulletin on its packings, packing tools, and rotary mechanical seal. Durametallic packings are made of aluminum, lead, or copper foils, lubricated with graphite, mica, and selected oils and greases. The metallic foils are crinkled and twisted about resilient fibre core materials and uniformly compressed into spirals or die-molded rings. Pages 2 and 3 of the bulletin show a table listing recommended uses of packings, types, and styles.

Circle letter (AZ) on reply card.

(BA) OIL FIELD PUMP

Chain Belt Company's latest bulletin is on the Rex oil field pump. Given the name, the "Speed-Primer", this new pump combines accessibility, simplicity, and portability. The new bulletin explains how the Speed Primer is designed for easy and inexpensvie replacement of wearing parts . . . removal of the cover plate makes it possible to replace or adjust practically all wearing parts in the pump. The new bulletin further explains the patented high carbon steel air peeler and the open type impeller, which assures maximum water handling ability.

Circle letter (BA) on reply card.

(BB) HEAT EXCHANGERS

Advantages and limitations of Allis-Chalmers totally-enclosed motors with air-to-water heat exchangers are related. in a new bulletin released by the company. Properly fitted enclosures to keep out dust, dirt, fumes, and excess moisture, according to the bulletin. The bulletin includes a description of the three types of cooler arrangement—foundation, side or top-mounting—built into the motors and explains how to estimate their water requirements. Allis-Chalmers Manufacturing Company.

Circle letter (BB) on reply card.

(BC) WIRE ROPE

A bulletin entitled "Wire Rope—So What?" was recently published by The Macwhyte Company. Regardless of make or model of wire rope, this discussion gives data to all wire rope users hints on how they can make substantial savings on wire rope. The article was written by Harold W. Richardson, from an interview with William C. Russell, chief wire rope and product engineer for Macwhyte. The article does not deal strictly with Macwhyte wire rope, but is intended to help all readers interested in keeping wire rope costs down.

Circle letter (BC) on reply card.

(BD) CONTROL SYSTEM

The Swartwout Company announces a 4-page bulletin on the new Swartwout autronic control system. Printed in two colors and illustrated with photographs, line sketches, dimensional drawings, and a schematic diagram showing principle of operation, the new bulletin describes the Swartwout autronic system as the first miniature all-electronic system for controlling pressure, temperature, flow, and level.

Circle letter (BD) on reply card.

(BE) CORROSIVE ATTACKS

For 25 years, The American Brass Company's technical staff has conducted continuous laboratory research and field study of the nature of corrosive attack on copper and copper alloys. The results of these studies have been published now in a 24-page booklet, "Corrosion Resistance of Copper and Copper Alloys." This publication explains the chemical and physical nature of corrosive attack in its various forms.

Circle letter (BE) on reply card.

(BF) ALKALIES BULLETIN

Solvay Sales Division, Allied Chemical and Dye Corporation, is offering a new, revised, edition of its technical and engineering service bulletin, No. 9, "The Analysis of Alkalies." The company advises that this third edition has been substantially enlarged and now contains 72 pages of text, tables, charts, and indexes. New additions or revisions include the recalculation of analytical factors to the basis of the 1948 International Atomic Weights, a colorimetric test for iron and copper and a temperature correction table for volumetric solutions.

Circle letter (BF) on reply card.

(BG) CONVERTERS

A new four-page, two-color bulletin on Tri-Clad induction frequency converters has been announced as available from the General Electric Company. Designated as publication GEA-5637, the booklet covers three-phase equipment in ratings from ¾ to 100 kw. It describes the fundamentals, operation, and construction features of the high-frequency power supply apparatus, and includes application information, modifications, and limitations, and complete tables of ratings and frame sizes.

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BOOKS

Relief Map of Venezuela, *published by Aero Service Corporation, 236 East Courtland Street, Philadelphia, Pennsylvania. Price, $31.50, delivered prepaid anywhere in U.S.A.*

A 45- by 56-inch relief map of Venezuela, weighing only two pounds is now available in the newly published second edition. Originally designed and published for a large oil company's public relations use in Venezuela, this map is based on a compilation of the American Geographical Society, which was edited for this special map. The map is made from Vinylite and printed in nine colors: Light lavendar on the peaks, peach and green for lower areas, and a darker green for the valleys. A very light peach tint is used for the overall background color; roads are printed in red; contour lines, grid lines, and place names in black. Light and dark blues are used for the ocean and inland streams.

Industrial Water Pollution, *compiled by the staff of R. S. Aries and Associates, Consulting Engineers. Published by Chemonomics, Inc., 400 Madison Avenue, New York 17, N. Y. Pages 142. Price, $5.*

This handbook lists and discusses the regulations on water pollution now in effect in every state and territory of the United States. All the essential facts, listed in alphabetical order of the states, provide a ready reference work. The various definitions of water pollution formulated by each state, the measures necessary to comply with the state's regulations, the enforcement procedures enumerated in the laws, and the steps that must be taken by manufacturers to abate water pollution, are discussed in detail. A complete list of all state agencies concerned with water pollution is found in the appendix.

A Glossary of Petroleum Terms, *published by the Institute of Petroleum, 26, Portland Place, London, W. 1. Pages, 16. Price, 1s 3d.*

This booklet is the first part of a glossary of petroleum terms being prepared by the Institute of Petroleum, which is attempting to give the definitions in such a language that those not versed in technicalities of petroleum might gain some benefit. The Standardization committee is still working on the Glossary, but as an interim measure, has published this first part of the larger work. This booklet gives the more widely known petroleum products and terms used in the industry, and gives 117 definitions of such items.

Industrial Piping, *by Charles T. Littleton. Published by McGraw-Hill Book Company, 330 West 42nd Street, New York 18, N. Y. Pages, 424. Price, $8.*

Slanted to the needs of practicing piping designers and erection foremen, this practical book explains the correct procedure for designing and erecting a modern industrial plant—from preliminary flow sheet and plot plan to the final erection drawings. Individual chapters discuss the flow calculation, preferred materials, fittings and valves for each type of piping service. This coverage includes steam, water, oil, gas, air, and instrument piping. A special chapter "Estimating Piping Cost," contributed by R. A. Dickson, describes the "N" factor system that he has developed. It is accurate to with ± 8 per cent of detailed cost estimates.

Physical Chemistry of Lubricating Oils, *by A. Bondi. Published by Reinhold Publishing Corporation, 330 W. 42nd Street, New York, N. Y. Pages, 371. Price, $10.*

This volume gives the latest theories on lubricating oils and the physical and chemical properties underlying their action. Such properties as viscosity, pour point, oiliness, flowing characteristics, foaming, etc., are discussed in great detail and attention is given to additives of all types. Simple methods for the estimation of unknown properties from a few given data will prove valuable to those in the lubrication field. An entire chapter is devoted to synthetic lubricants and there is a special section dealing with reaction kinetics involved in lubrication problems.